THE DENTAL PRACTITIONER

incorporating

THE DENTAL RECORD

VOL. V, NO. 11 JULY, 1955

Including the official reports of the British Society of Periodontology, the British Society for the Study of Orthodontics, the European Orthodontic Society, the Liverpool and District Odontological Society, the North Staffordshire Society of Dental Surgeons, the Odonto-chirurgical Society of Scotland, and the British Society of Dental Hypnotists

CONTENTS

Editorial : Dental History

Panoramic Tomography : Pantomography : Dr. Sydney Blackman

An Orthodontic Coil Spring Winder : C. P. Adams, B.D.S., F.D.S.

Requirements for Recording Data of Dental Examination in Caries Control Studies
Louis J. Baume, D.M.D., M.S.D.

Basal and Alveolar Bone : J. H. Scott

Notes on Income Tax : John Lymester

The Physiology of Mastication : D. J. Anderson, Ph.D., M.Sc., B.D.S.

Society Notes Book Reviews Letter to the Editor

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VOL. V, No. 11 July, 1955

CONTENTS

	PAGE
EDITORIAL: DENTAL HISTORY	367
PANORAMIC TOMOGRAPHY: PANTOMOGRAPHY — *Dr. Sydney Blackman*	368
AN ORTHODONTIC COIL SPRING WINDER — *C. P. Adams, B.D.S., F.D.S.*	370
REQUIREMENTS FOR RECORDING DATA OF DENTAL EXAMINATION IN CARIES AND CONTROL SERIES — *Louis J. Baume, D.M.D., M.S.D.*	376
BASAL AND ALVEOLAR BONE — *J. H. Scott*	381
NOTES ON INCOME TAX — *John Lymester*	387
THE PHYSIOLOGY OF MASTICATION — *D. J. Anderson, Ph.D., M.Sc., B.D.S.*	389
SOCIETY NOTES	396
BOOK REVIEWS	400
LETTER TO THE EDITOR	402
NATIONAL HEALTH SERVICE NOTES	403
ABSTRACTS FROM OTHER JOURNALS	375, 403
EXAMINATION RESULTS	405

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THE
DENTAL PRACTITIONER
Incorporating the "Dental Record"

Vol. V, No. 11 July, 1955

EDITORIAL

DENTAL HISTORY

To the average schoolboy History is just a memory test of a series of dates in the calendar of time. To the student it is a subject whereby an understanding of the reasonings behind historic actions may be studied. We learn throughout life not only from our own experiences but an even greater amount from the experiences of others. The history of the universe is the experience of the past, a study of which in theory should teach us not to make the same mistake twice. It is said that history repeats itself, but the apparent repetition is never obvious at the time for the environmental circumstances are changed. It is sometimes claimed that events are so different that a parallel in history cannot be drawn, and that in any case intellectual evolution has advanced to such a degree that our problems can be solved without reference to history. Nothing could be wider from the mark. The Dental Profession by a study of its own history can learn a great deal from its past and from the mistakes that have been made during the last century. The clock cannot be put back and not one single second can be relived, but the future can be guided by the past. With an already full curriculum it is difficult to teach dental history fully in the dental schools, nor is it easy for the practitioner to find time to sit and read of the glories of the past and the pitfalls that we must avoid. With this in view, and without detracting from the worth of the excellent books on the history of dentistry, we bring to your attention a small pamphlet on *Dentistry as Practised*, by Menzies Campbell. It is short and to the point and is in the author's words "a bird's eye view of the fight for status and prestige" of the Dental Profession. It may be read in an hour, but it is hoped that the interest it will arouse will promote a greater understanding of the problems of the past and their solution. It reminds us forcibly of the maxim that united we stand, divided we fall, and of the tremendously hard work that has brought the profession through all the vicissitudes of its life.

N. L. W.

NEW HOSPITAL BUILDING PLAN

THE Minister of Health, in answer to a parliamentary question on Friday July 1, gave a list of major projects which have been selected for the first programme of new hospital building since before the war. Among these is a new dental hospital to be attached to University College Hospital.

PANORAMIC TOMOGRAPHY: PANTOMOGRAPHY

By **Dr. SYDNEY BLACKMAN**
Director, X-ray Department, Royal Dental Hospital

A NEW form of extra-oral radiography has been devised by Dr. Yrjo V. Paatero, of Helsinki, who, with a special apparatus developed by him in Finland, is able to record on an ordinary flat X-ray film any curved layer of an object. There is still much experimental work yet to be undertaken, both from the mechanical and mathematical aspects, but it is hoped that before the end of this year pantomography will prove to be a reliable and useful method of radiography, especially in the dental field.

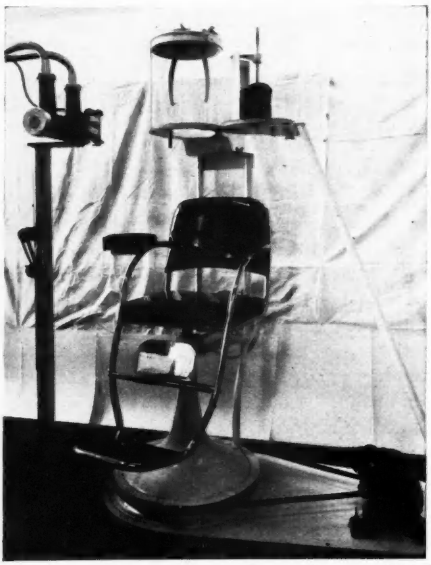


Fig. 1.—The motor-driven dental chair on which is fixed a special craniostat together with the disk-like table carrying the film on a holder.

During the last fifteen years or more there have been different systems or different mechanical arrangements with terms such as tomography, planigraphy, laminography, and stratigraphy, which have all been utilized to produce a similar result—body section radiography. The method of X-ray examination in all these cases involves the moving of the X-ray tube in one direction while the film moves in the opposite direction, at a proportional rate. The film and tube rotate about an axis in the plane which it is desired to radiograph.

The effect of this contra-movement is that there is one "layer" of an object which is constant in relation to the tube and to the film, because the movement is in constant ratio, and the shadow of every particle in that "layer" will continue to fall on the same point on the film. Points above and below that "layer" will fall on different parts of the film and consequently become blurred.

Routine radiography is a superimposed picture of all the layers of a particular region of the body, and deep pathological conditions are extremely difficult to demonstrate clearly because of overlying structures. With the tomograph, however, we are enabled to take X-ray films of different layers of a region and get through or round the dense portion of tissue or structures obscuring the part to be investigated. The thickness of the layers varies with the focal-film distance and the distance through which the tube moves.

Pantomographic roentgenology is distinguished from all the above tomographic methods in that it produces panoramas of the different layers of a curved object, and hitherto its main application has been concentrated in the radiography of the face and teeth. For this work the pantomograph consists of a motor-driven dental chair on which is fixed a special craniostat, and, in revolving, it activates a disk-like table carrying the film on a holder (*Fig.* 1). The technique is based on the fact that the craniostat and the film table must be of the same diameter and each moves around its own axis, in the same direction with the same angular velocity. Therefore, at given

points, equidistant from their respective axes on object and film, there is a common linear velocity and the points at a given moment are stationary with respect to one another.

projected on the sensitive surface (*Fig.* 3). The other layers of the object are blurred on the film because their shadows move on it and appear either as dim foggy stripes or do not

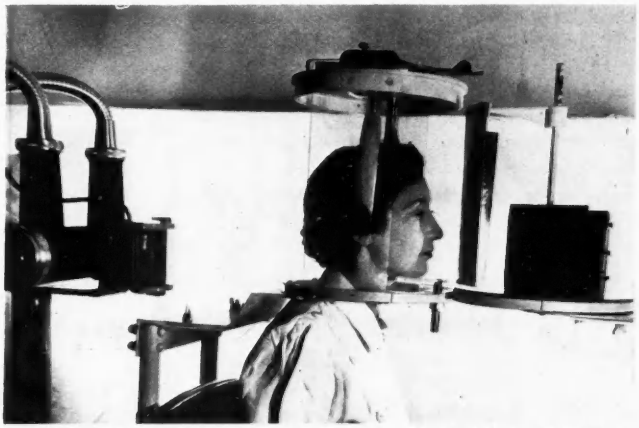


Fig. 2.—The patient's head is located in the craniostat. On the right is the disk-like table carrying the film on a holder. On the left the fixed position of the X-ray head.

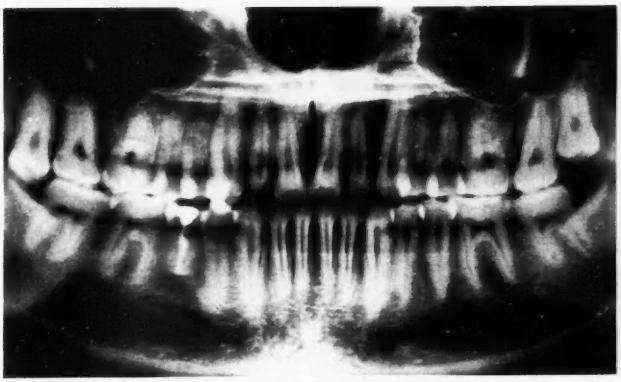


Fig. 3.—Specimen of a pantomographic film giving a radiographic picture of all the teeth in one sitting.

In pantomography the X-ray tube is stationary and the X-ray beam is directed postero-anteriorly through the patient's head at the rotation axis towards the axis of the film holder on the table (*Fig.* 2), and, because the object and film move with the same linear velocity, the layer under review does not shift with respect to the film and is accordingly

appear at all, depending on the density of the object and on some other factors to be considered.

It is premature at this stage to describe in detail the actual structure of the apparatus, the accessories, and the basic calculations and adjustments associated with the craniostat and revolving film-holder disk: there are still many

mechanical alterations to be considered and tested. The development of this unique apparatus with its new techniques is being undertaken in the X-ray Department of the Royal Dental Hospital in London concurrently with experimental work by Dr. Paatero in Helsinki, and fuller details will be published at a later date.

It might be opportune to emphasize that the pantomograph is not intended to oust or supplant the present methods of intra-oral and extra-oral radiography, but rather to implement our means of investigation. The main objective at the moment is to perfect and stabilize the apparatus so that it can be employed on a national scale for *mass dental radiography*, in order to obtain from early childhood a comprehensive survey of tooth development. This will be followed up by a technique to identify the presence of pathological conditions and, later, when good definition is possible, to undertake extra-oral examination of coronal conditions.

The potentialities are many and the advantages great, for the examination is carried out with one film placed outside the face, with no inconvenience or distress to the patient. As soon as a child is able to sit upright in a feeding chair it will become eligible for a pantomographic dental examination.

AN ORTHODONTIC COIL SPRING WINDER

By **C. P. ADAMS**, B.D.S., F.D.S.

COIL springs find a great variety of uses both in fixed and removable orthodontic appliance technique and it is important, therefore, to have at hand a rapid and reliable method of forming these springs in different diameters and different gauges of wire. The winder that is illustrated in this paper has been in use for many years at the Eastman Dental Hospital, London, where it was introduced by Mr. J. S. Beresford. The inspiration for this device came originally from a winder, identical in principle but rather different in design, described by Lowrie J. Porter (1941, 1943). The present author has made a few small modifications to the Eastman pattern that make for greater ease in construction and speed in operation, but does not claim any originality for the device as a whole.

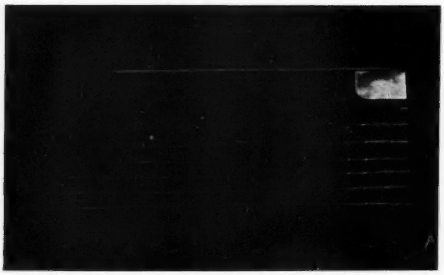


Fig. 1.—Winding jig, lining tube, and six winding mandrels sizes 1·0 mm., 0·9 mm., 0·8 mm., 0·7 mm., 0·6 mm., and 0·5 mm. thick. The mandrels are graduated in length from thickest to thinnest, so that selection of the required size is facilitated.

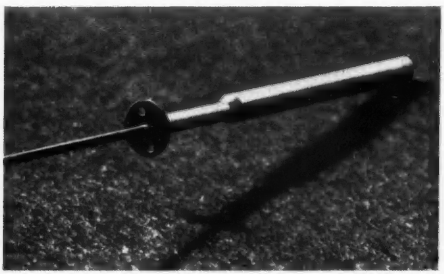


Fig. 2.—A mandrel showing the shank, made from a bur or straight handpiece mandrel with a disk 5–6 mm. diameter perforated in two places. One of these holes is used to retain the spring wire during winding of the spring.

The winder consists essentially of a series of mandrels made of stainless steel wire from 0·5 mm. to 1·0 mm. thick, on which the coils are wound. This range of diameters will cover all normal orthodontic coil spring requirements. These mandrels run in a stainless steel tube, 1·0 mm. internal diameter, and the spring wire is fed in at right angles through a fine 0·5-mm. internal tube (*Fig.* 1). The spring

wire is attached to the mandrel temporarily by means of a perforated disk fixed to the mandrel through a hole in which the spring wire is passed (*Fig.* 2).

Construction of the Mandrels.—The mandrels are constructed from hard stainless steel wire, straightened as well as possible and soldered and band material are then soldered together using a minimum of solder and heat (*Fig.* 3 C).

It will be found that the finer mandrel wires are a rather slack fit in the tubing and may be a little eccentric when soldered in, but this does not affect the efficiency of the winder. When making the 0·5-mm. mandrel it is helpful to put a piece of 0·5-mm. tubing inside the 1·0-mm. tubing. This will centre the mandrel accurately.

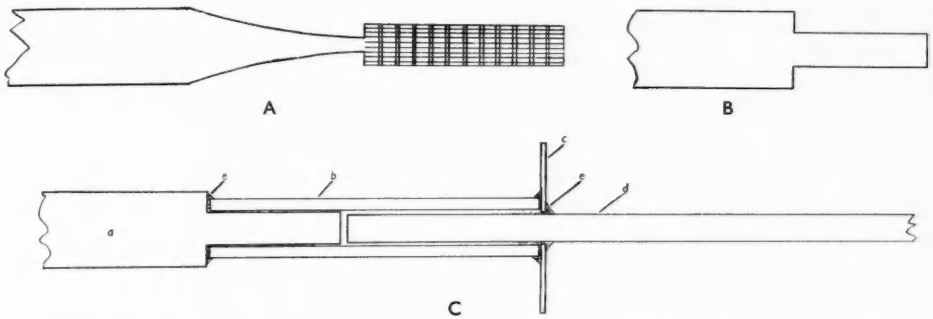


Fig. 3.—Construction of winding mandrel from straight handpiece bur shank. A, Bur, any kind can be used. B, Bur ground down forming stub 3–5 mm. long and 1·0 mm. thick. C, 1·0-mm. tubing soldered over stub. A long piece is used to facilitate soldering and tubing is then cut off leaving 1·0 cm. attached to bur (*a*, *b*). The winding wire (*d*) is then fitted in and a plate of stainless steel tape (*c*) is fitted over the wire and the whole soldered together (*e*).

onto a straight bur shank through the medium of a short length of tubing. The bur is first ground down at the end to a diameter of 1·0 mm. forming a short stub 3·0 mm. long with a definite shoulder at the junction with the bur shank (*Fig.* 3 A and B). This stub is most easily formed by holding the bur in a straight handpiece and, while running the bur rapidly, holding it against a fine, new carborundum wheel which is running on a lathe. If this wheel is reasonably new a definite sharp step can be formed where the stub projects from the bur shank.

A length of 1·0-mm. tubing is next fitted over the stub and soldered on. This tube is then cut off, leaving about 1·0 cm. attached to the bur shank. The piece of wire from which the mandrel is to be made is straightened and pushed into the open end of the tubing. A piece of steel molar band material 5–6 mm. square and at least 0·15 mm. thick is perforated centrally with a hole of the same size as the mandrel wire and is slipped onto the wire and pushed right up against the tubing. Tube, wire,

The square plate of stainless steel is next turned into a circle by rotating the mandrel in a handpiece and holding the edge of the plate lightly against a rotating carborundum wheel. Two small holes are finally drilled in the disk with a spear point drill and the whole assembly smoothed off and polished.

It is helpful to make the set of mandrels of different lengths, the thickest being the longest, each successively thinner mandrel being shorter by 1·0 cm. or $\frac{1}{2}$ in. A useful selection of mandrels is 1·0 mm. reducing by 0·1 mm. to 0·5 mm. thick, which is about the thinnest that it is practicable to use. This will give a set of six mandrels which may be selected at will by their lengths. The longest mandrel does not need to be longer than 10 in. overall, making it possible to wind a spring of about 8 in. in length if necessary.

An alternative method of constructing mandrels is to start with the conventional

straight handpiece mandrel as used for sandpaper disks, discarding the central screw at the head (*Fig.* 4 A). The flange at the end is ground off (*Fig.* 4 B), and the winding wire fitted into the central hole with the square of tape in position and the mandrel, wire, and tape soldered together as before (*Fig.* 4 C).

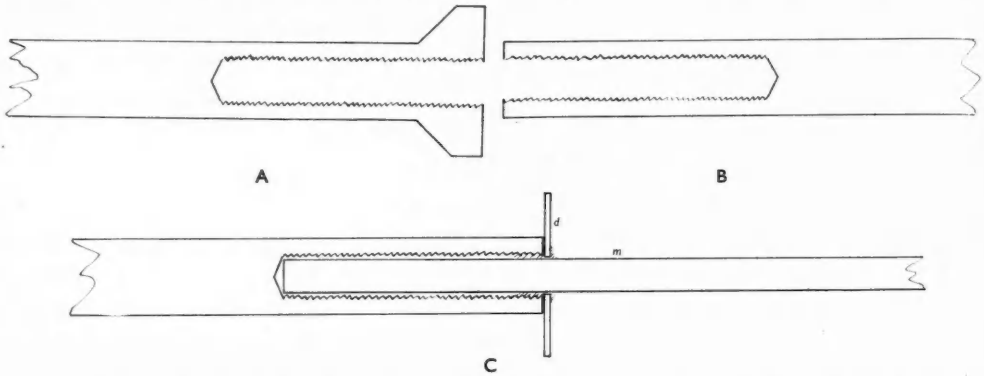


Fig. 4.—Construction of winding mandrel from a straight handpiece mandrel, A. The flange is ground off, B. The plate of stainless steel and winding wire are fitted as in *Fig.* 3 and soldered together.

Fig. 5.—The relationship of the working ends of the winding tube (1·0 mm. internal diameter) and the feeder tube (0·5 mm. internal diameter).

The complete mandrel is then finished off by rounding the square of tape into a circle, perforating, and smoothing off.

The Winding Jig.—The winding jig consists of a piece of 1·0-mm. internal stainless steel tube, 7–8 in. long, soldered to the long edge of a piece of 24 gauge stainless steel plate approximately 3 × 2 cm. in size. Along the adjoining edge of the plate is soldered a finer shorter length of tubing 0·5-mm. internal diameter (*Figs.* 1, 5). It is a great help if these pieces of tubing can be lightly tacked to the plate by welding before they are soldered. The alinement of these tubes and the relation of their ends should be carefully noted (*Figs.* 5, 6).

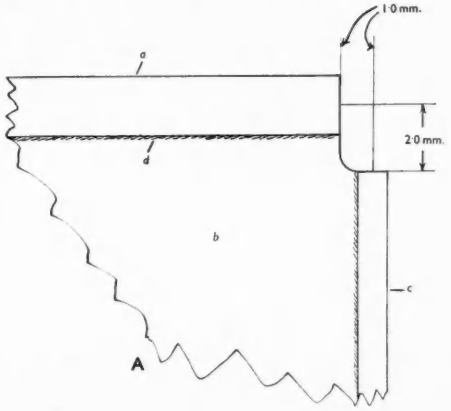
Use of the Winder.—The spring wire is fed through the fine tube until about 1·5 mm. project past the large tube. The mandrel is inserted past the fine wire into the large tube and pushed in until the disk is approaching the projecting end of the spring wire. The spring wire is bent over and led through one of the holes in the disk and the mandrel pushed right home. About 1 cm. of spring wire should project through the hole in the disk. The mandrel is then put into a straight handpiece and the engine set in motion, when the coils will become wound on the mandrel (*Fig.* 7). It is necessary to control the rate at which the mandrel is withdrawn from the tube to prevent either an open coil being wound or the coil wire from riding over coils already formed and jamming the winder.

The most generally useful way of winding coil springs is to wind them all closely, that is with all the coils touching each other. Such coils are then "set" to give their optimum working range in compression by stretching the spring by its extreme ends an adequate amount. The spring will be found to stretch perfectly uniformly. The spring is then replaced on the mandrel and compressed

completely. When released the spring will be found to return to a certain point. The useful working range of the spring in compression lies between this point and total compression, because it is known that total compression will not deform the spring and that it will always return to the point from which it was compressed. The various procedures that have been advocated for winding coil springs with the coils already spaced, for example, by winding the spring wire side by side with soft or inert wire which is subsequently removed, seem to be unnecessarily complicated.

Some operators prefer to wind wire directly off the spool onto the coil winder. This method is not always suitable when spools of wire are kept in a dispenser, and it is found to be much more satisfactory to remove a length of wire, 4–6 ft. in length, and to use this for coil winding. The entry of the wire into the feeder tube can be controlled by passing the wire through the fingers of the left hand (*Fig.* 8). If the loops of unwound wire are allowed to hang loosely and a careful winding speed is used, there is no tendency for tangle to occur and the wire uncoils itself naturally as it passes through the fingers.

When winding springs on the 0·5-mm. mandrel, the mandrel is often found to be unstable inside the 1·0-mm. winding tube and difficulty may be experienced in obtaining a smooth coil spring. The difficulty may be



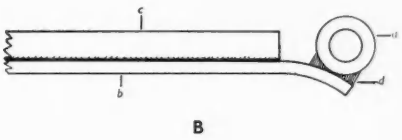


Fig. 6.—A, Plan of the arrangement of the ends of the winder and feeder tubes. The dimensions shown should be carefully observed to secure the best results. B, View of the winding tube, end on. Note that the edge of the plate is bent down so that the centre line of the feeder tube is level with the centre of the winding tube. It is then possible to wind springs in either direction with equal tension. *a*, Main or winding tube; *b*, Steel baseplate material; *c*, Feeder tube; *d*, Solder.

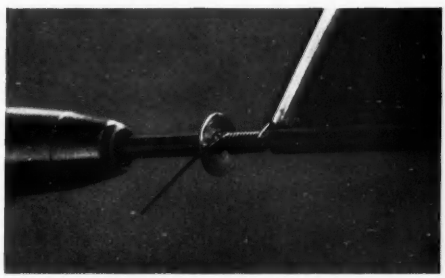


Fig. 7.—The winder in use. This spring is being wound in a right-handed manner. The mandrel may, however, be equally well rotated in the opposite direction.

Fig. 8.—The winder in use. The spring wire is controlled by the fingers of the left hand. The wire can be seen entering from below. A slow winding speed should be used until experience has been gained in controlling the entry of the wire and withdrawal of the mandrel from the jig.

overcome by lining the 1·0-mm. tube with a length of 0·5-mm. internal tubing. The lining tube must be prevented from rotating and moving longitudinally inside the larger tube. This liner is stabilized by means of a cuff or clip of band material welded or soldered to the outer or far end of the liner which clips over the outside of the outer end of the main winding tube. The construction of this part is shown in *Fig.* 9. When winding coils on the 0·5-mm. mandrel, therefore, the lining tube is slipped into the main winding tube and the clip or cuff steadies the fine tube in the larger one. At the inner or working end the lining tube must be quite flush with the outer tube and must not project.

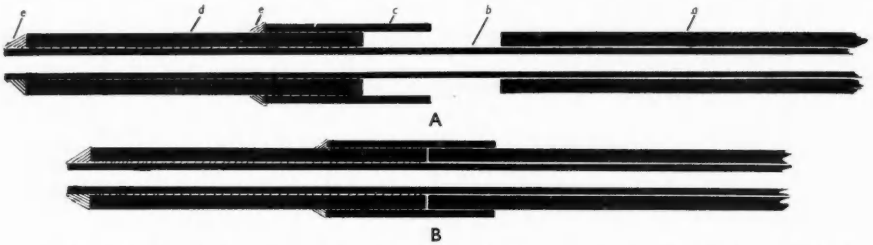


Fig. 9.—A, Section showing construction of the lining tube for the main winding tube for use with the 0·5-mm. mandrel. *a*, The main winding tube; *b*, The 0·5-mm. lining tube; *c*, A cuff of steel band material, soldered to the short length of 1·0-mm. tube; *d*, A short length of 1·0-mm. tube soldered to the lining tube at the end; e, Solder. B, The lining tube pushed home. The cuff of steel fits tightly over the winding tube so steadying the lining tube. The other end of the lining tube is flush with the end of the outer tube.

Removing the Spring from the Winder.—During the course of winding, the spring is bound tightly around the mandrel, which cannot be withdrawn from the spring while there is any wire still in the feed tube. The mandrel, spring, and jig can be separated in two ways:—

1. If the supply of spring wire runs out and the last of the wire is wound onto the mandrel, the tension of the spring is released and the whole spring unwinds slightly and relaxes its grip on the mandrel. The mandrel can then be withdrawn from the jig and the spring pulled off the mandrel; the tail of wire projecting through the hole in the disk slips out perfectly easily.

2. If it is desired to withdraw the spring from the winder before the supply of wire has run out, or in order to leave a coil spring with a tail of wire attached, it is important first to release the tension in the spring which is gripping the mandrel. This is done by releasing the grip of the handpiece on the shank of the mandrel. The spring and mandrel then unwind slightly and the grip of the spring on the mandrel is released. The mandrel is then pulled out and the spring is removed from the jig by drawing the unused portion of the spring wire, attached to the coil spring, through the feeder tube.

POINTS TO REMEMBER

Coil springs can be wound with this simple apparatus in wire from 0·45 mm. thick downwards on mandrels from 1·0 mm. thick downwards. It will naturally be found that it is not feasible to wind a thick wire on a thin mandrel; a point will be reached where the mandrel will not stand the strain or the engine used for driving the device will become overloaded. Up to this point, however, there is a very large range of coil springs that can be made using different combinations of thicknesses of wire and thicknesses of mandrel.

In practice, coil springs are generally made of wires 0·15 mm. or 0·2 mm. thick. Thicker wires give springs which are too powerful and have too short a range of action. For twin-wire arch coil springs, 0·15-mm. wire wound on a mandrel 0·5 mm. thick gives a very suitable spring. For springs of larger diameter, that is 0·8 mm., 0·9 mm., or 1·0 mm., wire of 0·2 mm. thickness may in certain circumstances be used.

The thicker wires, 0·3 mm., 0·35 mm., and 0·4 mm., are more suitable for Trevor Johnson friction fit stops which are wound on a mandrel one size, or 0·1 mm., smaller than the arch on which they are to be used. The author finds that for these stops it is better to use a large number of coils of a fairly fine wire than a small number of coils of a thicker wire, i.e., six turns of 0·3-mm. wire rather than two or three turns of 0·4-mm. wire. The former stop will be as firm as, but more resilient in itself and less likely to loosen in use than, the latter. On the other hand, if the friction fit attachment is to be used also as traction hook by forming a free end into a hook, a firm wire must be used for the purpose of the hook and therefore a 0·4-mm. wire requires to be used for the whole attachment.

The winder can also be used for both right-hand and left-hand coils, a point that must be taken into consideration when the end of the wire is to be used for spring or hook purposes. A winder of this type once made up will last for years, the only replacement being possibly the occasional reconstruction of one of the finer mandrels should breakage occur.

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PERICORONAL INFECTION

Inflammation around the crown of an unerupted or partially erupted tooth may occur anywhere in the mouth, but is most commonly found in the lower third molar region. The condition is more likely to occur in unerupted teeth when a gingival perforation is present which provides access to the epithelial-lined space between the remnant of the tooth sac and the crown of the tooth. This space or pocket affords an ideal environment for the colonization of pathogenic bacteria and the resulting infection may involve the gingival flap covering the occlusal surface. The most frequently affected sites are those distal to the crown of the tooth and the wedge-shaped space beneath the mesial surface of the inclined tooth which has become infected. Any condition which tends to lower resistance may be a precursor of pericoronal infection. The cases are to be classed as dental emergencies, along with acute alveolar abscesses, and, in the case of lower third molar, the proximity of the facial planes remembered. The condition is very often an acute exacerbation of a pre-existing sub-outer or chronic inflammation, and the patient may be very ill. The temperature may be high, there may be malaise, a swollen face, and enlarged submaxillary glands. The accompanying trismus is due to the presence of buccinator and superior constrictor muscle-fibres in the occlusal flap (Miller).

Treatment.—Apply general surgical principles—heat, rest, and drainage—at the outset until the acute inflammation has subsided. Irritation from an opposing tooth may be eliminated by grinding or extracting such a tooth. Hot mouthwashes and (Miller) ice-packs externally. Rest in bed is indicated for the toxic patient. Should an abscess be present in the buccal sulcus or in the soft tissues overlying the retromolar triangle, drainage should be established by incising the fluctuant area. Flaps should be gently lifted, cleaned of any debris, and syringed. Antiseptics may be applied here; however empirical this may be, it appears to do good. Such drugs include: gentian violet, tincture of metaphen, 2·5 per cent iodine, chromic acid, hydrogen peroxide, silver nitrate, and trichloracetic acid crystals. These measures may be coupled with general therapy, i.e., copious fluids, aperients, and antibiotics. On subsidence of the acute stage the following courses are available:—

1. *Removal of the flap*: This may be difficult. Gingivectomy knife or electrocautery can be used.

2. *Removal of the tooth*: If this course is decided upon it is all the more important that all acute inflammation should have subsided, and large doses of antibiotics used unless contra-indicated for other reasons.—MACALISTER, A. D. (1954), *N.Z. dent. J.*, **50**, 114.

REQUIREMENTS FOR RECORDING DATA OF DENTAL EXAMINATION IN CARIES CONTROL STUDIES

By **LOUIS J. BAUME**, D.M.D., M.S.D.*

SCIENTIFIC evaluation of the prevalence of dental decay remains a corner stone of modern caries research. Data on caries incidence are needed for several purposes: (*a*) to supply information for epidemiological studies, (*b*) to appraise the need of dental service in public health surveys, and (*c*) to measure the efficacy of a preventive therapy. The procedures of collecting data obviously should be fitted to the type of study planned. While epidemiological and public health surveys call for mass screening methods by means of rather abbreviated dental examinations, clinical tests of caries-reducing agents exact a more detailed checking on the individual caries activity through the use of serial observations.

Longitudinal studies designed to assess the past and present caries experience of a random sample of individuals rank among the most difficult scientific attempts. Any clinical assessment of caries has to cope with the following three obstacles:—

1. Defining the carious lesion, especially at the incipient stage (the qualitative aspect of dental caries);

2. Grading the extent of a carious lesion or its restorative replacement (the quantitative aspect of dental caries);

3. Recording the data on caries frequency (the rate of dental caries).

Lack of generally accepted standards with regard to these three aspects of the clinical caries picture is responsible for the present heterogeneity of results reported in the literature[1, 2, 3, 4] to render impossible any valid comparison of data. A unification of the terms expressing data, as well as the adoption of standard criteria permitting reproducibility of clinical examination, is a project of primary importance to investigators concerned with the evaluation of caries control measures.

On the basis of the evidences presented in the literature† and the experience gained in a longitudinal fluorine experiment with 2000 students during a four-years' period[5] some suggestions are herewith submitted for delineating standards of recording data in caries control studies. Requirements for the conduct of epidemiological and public health surveys programmes are not dealt with.

1. DEFINITION OF CARIOUS LESION FROM CLINICAL POINT OF VIEW

The bacteriochemical definition of caries is based on the microscopical evidence of decalcification and bacterial invasion. However, this is of little help to the clinical diagnosis of caries, especially when dealing with its initial phase.[6, 7] According to their location three types of carious lesions can be differentiated: (*a*) pit and fissure caries, (*b*) proximal surface caries, (*c*) smooth surface caries.

Each of these types calls for a specific method of diagnosis—namely (*a*) physical examination with explorer and mirror, (*b*) radiographic examination, (*c*) colorimetric method.

Pit and fissure caries is ascertained by direct dental examination with explorer and mirror. Any discoloured soft spot, caught by the sharpened point of the probe, should be regarded as a potential lesion and be recorded as such.[8, 9] Radiographs do not reveal pit and fissure caries before penetration into the dentinal portion has occurred.[10]

Early proximal lesions unless freely accessible, particularly in the anterior teeth, can be detected with the help of radiographs only.[10] They appear in form of V-shaped defects in the enamel walls. Reports in the

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† A comprehensive review of the literature is found under references 1–4.

literature[5, 11, 12, 13, 14] uniformly show that a high percentage of proximal caries (50 per cent on the average) will escape visional inspection.

Incipient neck lesions often are difficult to be differentiated from non-carious defects such as erosion and hypoplasia. This makes pumicing and drying of the suspected areas necessary.[9, 15] Application of colorimetric methods, recently proposed by Arnim and Hardwick,[16] will possibly facilitate the diagnosis of true caries.

A study concerned with the preventive aspect of caries should attempt the recognition and registration of every carious lesion of the earliest perceptible stage. This lends itself to a better differentiation between caries prevention, the inhibition of new caries, and caries arrest, inhibition of progress of old, possibly not recognized, caries.[13, 17] The use of bite-wings, therefore, as a supplementary technique to physical examination, is an imperative need in caries control studies.[13, 18, 19] Adequate radiographic examination calls for a minimum of (*a*) three small-size films to cover the anterior teeth,* and (*b*) four posterior bite-wing films to depict the premolar and molar region of each side.[11] It has been shown by several investigators[14, 20, 21, 22] that in contrast to caries control studies, radiographic examination is not needed for the conduct of epidemiological and public health surveys.

In summarizing it must be emphasized that the conclusiveness of any clinical study of the effectiveness of caries-inhibiting agents will be in large part determined by the thoroughness and carefulness of the clinical assessment of caries. As opposed to epidemiological prevalence studies, a multiplicity of detailed information is needed.

2. METHOD OF RECORDING INFORMATION OF DENTAL EXAMINATION

It is important to collect from each examinee as many dental data as possible and to register them on an individual record card bearing name, address, origin, racial extraction, birth place, and places of living. Data of dental examination should comprise a scheme of the eruption state, open carious lesions (primary and secondary ones), extractions, and a complete record of the dental repair work. The circumference of every lesion or filling should be reproduced on the scheme. Boedecker[23] and Parfitt[24] have suggested the inclusion of a grading of the depths of the lesions. Radiographs must be on hand while examination is taken. Missing teeth are to be classified into extracted ones due to decay and absent or lost ones due to other reasons such as aplasia, retention, orthodontic treatment, etc. The state of the oral hygiene should be appraised as excellent, satisfactory, or poor. Incidence of erosion, hypoplasia, severe malocclusion, and tooth migration should also be recorded.

With all these examining criteria delineated, there is still left a wide range of personal interpretation as to the actual occurrence and extent of carious defects.[11, 13, 25, 26, 27] In order to obviate the difficulties of making comparable observations, it is an essential requirement that each individual be serially examined by one and the same investigator. As shown by Knutson[20] and Jackson[9] epidemiological screening of caries experience can be performed by several examiners without affecting the validity of records.

At the time of the second control, the record card and both sets of bite-wings should be on hand. Any difference from the earlier record as to new lesions, secondary caries, new fillings in the place of primary lesions, will be registered individually either on a new scheme or on the same but in a different colour.

In order to reduce any interpretative error and the possibility of personal bias in conducting caries control experiments, the following two essential principles should be respected:—

1. The investigator should present a clearly defined description of how the dental examination was conducted and what criteria were used.[1, 2]

2. In dealing with experimental and control groups the examiner should be unaware of the group to which any test subject belongs.

* Through the use of transmitted lighting, anterior radiographs may become superfluous.

3. EVALUATION OF DATA ON DENTAL EXAMINATION

For the purpose of estimating the past and present caries experience of a population group there are four units that can be utilized: (*a*) the individual, (*b*) the tooth, (*c*) the surface, (*d*) the lesion.

The individual unit is to be considered for the determination of the percentage of caries-free individuals of a population only.[2]

The tooth unit has found wide acceptance in the so-called DMF (decayed, missing, filled) rate per 100 individuals, introduced by Palmer and Klein of the U.S. Public Health Department.[29] It is an adequate method for assessing caries prevalence of large communities for epidemiological surveys.

Caries control studies on a smaller scale, however, require a more detailed consideration of the frequency of attack on any specific tooth surface, in order to establish the number and type of new caries arising within a given period. The DMF Surface Index has frequently been employed for this purpose although a great number of errors is inherent of this approach:—

1. Restorations are frequently extended to surfaces not involved by caries.[30]

2. Measures of degree of caries and DMF-counts do not run parallel.[31]

3. Incidence of new secondary caries is not registered.

4. Extracted teeth with five surfaces may have had a smaller number of areas affected by caries.[32, 33]

5. Exfoliated, missing deciduous teeth are not necessarily decayed.[34]

In view of the latter difficulty only the "Df rate" has been considered in the tabulation of deciduous teeth, missing teeth being excluded. Under the term "observable dental caries experience" (def), according to another system adopted by the American Association of Public Health Dentists, carious or filled teeth and teeth indicated for filling or extraction are included.[35]

A better differentiated method has been introduced by Boedecker,[8] who assigned each tooth an individual number of susceptible surfaces. This "Boedecker Count Index" (BCI) proves to be closely correlated with the "DMF Surface Index".[31, 36, 37] The possibility of a separate evaluation of the three types of carious lesions and of new secondary lesions possibly constitutes the sole advantage of this BCI-system.

Other suggestions have been made to obviate the inadequacies of current methods such as the "Moulage System" by Westin and by Dahlberg[38] and the Bernese-Index by Tschäppät.[39] The advantage of greater accuracy gained by these methods, however, is levelled by the disadvantage of their lesser practicability. The claim for more expedient and better reproducible recording procedures has prompted Winkler, Backer Dirks, and associates[13] to use reproducible radiographs of the premolars and molars for evaluation of proximal caries only.

Any adequate method of recording data in caries control studies, however, should be accurate as to incidence and degree of caries, reproducible, and practical, as well as representative for the anterior and posterior teeth.

4. REQUIREMENTS IMPLIED BY RATE OF CARIES PROGRESSION

The duration of any caries control study and the periodicity of re-examination are dependent on the rate of caries progression. The time involved in the spreading of a carious lesion has found little attention in the literature. Shepherd[40] made an attempt by plotting proximal surface lesions of serial radiographs on graph paper. Boyd[41] found high individual variability in the yearly increment of caries even under constant dietary and environmental conditions. Knutson's[42] extensive caries surveys of the American schoolchildren demonstrate an age specific caries prevalence rate consisting of a steady increase in the DMF rate by about 0·7 to 1 unit per year with progressing age. Furthermore, there is considerable evidence[2, 3] to indicate a variance in caries progression among both sexes; caries experience appears to be higher in males in the younger ages and higher in females in the older age groups. Owing to the dependency of the caries rate upon age and sex factors, Toverud[28] calls for an age grouping within

narrow limits of one year and recommends the extension of observations to at least two years.

The evaluation of our Californian material leads to similar conclusions.[5] Examining the age groups of 18- to 21-year-old students serially during four years it was hardly possible to detect radiographically new proximal lesions within a year's interval, the increment of new caries lesions being restricted to questionable pit and fissure and smooth surface caries. The straight line fashion increase in DMF rates shown by Knutson[42] apparently tapers off after the age of 18 years. Furthermore, it was found that the yearly increment of new caries depended upon the availability of susceptible surfaces; groups with initially high caries frequency showed less increase than groups with low caries rates at the start. A third finding pertained to the bilaterality of caries incidence. A statistically even distribution and identical progress of caries frequency on both the left and the right sides of the dental arches only occurred if samples with a high number of individuals were used. Smaller samples of about 100 individuals showed discrepancies up to 40 per cent between the caries rates of the left and the right side. This is in agreement with Finn's statement:[2] "Although dental caries does occur bilaterally in the majority of teeth, cavities occur unilaterally in individual mouths".

According to the evidence presented, the following requirements should be considered in conducting caries control studies:—

a. A period of at least one year should intervene between two consecutive examinations in view of the individual inconsistency of caries activity.

b. The duration of the study should embrace a minimal span of at least two years since caries activity varies from one individual to another and between one period and another in the life of the same individual.

c. Group comparisons between two small samples (within the range of 100 individuals) are invalid unless their initial caries rate is equal or statistically adjusted since low-rate groups show faster caries progression than high-rating ones.

d. Provision should be made for a fairly even distribution of sexes among unselected random samples.

e. For halfside comparison large groups within the 500 to 1000 range are needed in order to secure bilaterally equal distribution of caries incidence.

5. NEED FOR STATISTICAL EVALUATION OF DATA

Any quantitative estimate of caries frequency includes a great number of errors. Employing adequate examining methods, high number of samples, etc., may reduce inaccuracies but not completely avoid them. The main difficulty rises from the fact that dental caries is a chance phenomenon with individuals differing in their susceptibility to tooth decay.

It is common practice to evaluate caries control measures by comparing groups of either treated individuals with untreated controls or the halfsides of treated dentures with the untreated other halves. The decrease in the rate of new lesions is usually expressed by a percentage value, well known as percentage of reduction. However, emphasis should be stressed upon the fact that this index does not reflect upon the behaviour of a subject as an individual but only refers to a group as an average. Furthermore, relatively little variation in the DMF averages of two groups may yield an unreasonably high percentage number, particularly when the basic rate of caries frequency is low.* Percentage numbers prove to be deceptive indices for expressing the rate of caries reduction;[44] as they give no possibility of determining whether the difference between two groups is situated between the limits of accidental fluctuation or is due to the operation of a specific factor.

A mean difference obviously is of little consequence unless subjected to close scrutiny as to the reliability of each mean and to the statistical significance.[1, 27, 45] In order to

* Reports of the Evanston Study[43] indicate a 75 per cent reduction in the caries attack on the upper permanent incisors six years after institution of artificial water fluoridation. In terms of DMF units the actual group difference between experimental and control groups, however, amounted to a mere two units!

determine the reliability two chief criteria are used:—

a. The width of the scatter of individual scores about the mean expressed by the standard deviation of observation according to the formula:

$$\sigma = \frac{\sqrt{\Sigma(X)^2}}{N-1}$$

b. A measure of the variation which is associated with the sampling process such as is expressed by the standard of the error according to the formula:

$$\epsilon = \frac{\sigma}{\sqrt{N}}$$

Hence, the larger the sample becomes the smaller is the standard correction to be applied to the mean and the more reliable the mean becomes for statistical purposes. Greater sample size obviously reduces the chances of error. Reversedly a small standard deviation allows the use of smaller samples. The estimation of adequate sample size in experiments, therefore, should be established on the basis of trends advanced through preliminary or pilot studies.

In order finally to test that a given difference between specific means is due to a specific factor and not mere chance, the significance of the difference has to be established according to the formula:—

$$\sigma_D = \sqrt{\left(\frac{\sigma}{X_1}\right)^2 + \left(\frac{\sigma}{X_2}\right)^2}$$

From this the critical ratio is calculated:—

$$\text{c.r.} = \frac{X_1 - X_2}{\sigma_D}$$

A critical ratio of 2 implies about a 5 per cent probability of chance; a critical ratio of 3 about 0·3 per cent. A difference to be significant, therefore, should be at least three times as great as the standard of error.

Statistical analysis calls for the computation of all individual data. Only very few studies reported in the literature have been subjected to such cumbersome statistical verification.[43, 46] This is said to be one of the reasons why the results of research into the prevention of caries are still so uncertain.[1]

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BASAL AND ALVEOLAR BONE

A STUDY IN DENTO-FACIAL MORPHOLOGY

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INTRODUCTION

White, Gardiner, and Leighton (1954) state that "The body of the maxilla and premaxilla and that part of the bone embracing the apices of the roots of the teeth is termed 'basal bone' by orthodontists". In the lower jaw "The body of the mandible and that part of the bone embracing the apices of the roots of the teeth is termed the basal bone". They also write: "It may be accepted that the genetic pattern of the basal bone is incapable of alteration by orthodontic treatment." It should be noted that according to their definition the basal bone of the jaws includes the apical base as defined by Lundstrom (1923).

Hovell (1953) states: "The dental arch is formed by muscular forces guiding the crowns of the teeth, within the limits permitted by the size of the basal bone within which the apices of the teeth are situated."

Brodie (1950) writes: "Basal bone has never been defined but seems to be accepted by most orthodontists as the skeletal bone which supports alveolar bone. This implies a boundary, or at least a zone, which lies between and is common to both."

It is proposed in this paper to attempt a more precise definition and demarcation of the entities "basal bone", "alveolar bone", and "apical base".

COMPARATIVE ANATOMY

Upper Jaw.—*Fig.* 1 shows a section through the maxilla of a sheep. This section shows the socket of an upper tooth which forms part of a trough-like structure projecting freely into the nasal cavity and maxillary antrum. This trough carries all the cheek teeth and is continuous behind with the alveolar bulb

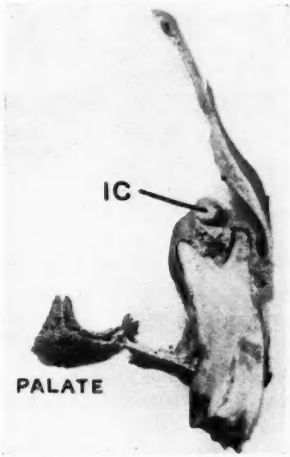

Fig. 1.—Coronal section through the maxilla of a sheep to show the relationship of a tooth socket to the facial skeleton. I.C., Infra-orbital canal.

(*Fig.* 2). The infra-orbital canal runs along the base of the trough close to the apices of the teeth. In animals such as the sheep this nerve has no relationship to the orbital cavity for the greater part of its course as it runs forwards through the facial skeleton. It is, however, the sensory nerve to the upper cheek teeth, the nasal mucous membrane, and the skin covering the upper part of the facial

skeleton, and as such corresponds to the infra-orbital nerve of human anatomy. It will be observed that the apical base, the bone related to the apices of the teeth, is part of the socket bone and has no relationship whatever to the remainder of the facial skeleton. In animals with snouts the upper facial skeleton in front of the orbital cavities forms a tube-like structure surrounding the nasal cavities. This tube-like form gives strength to the skeleton. At the back of the face the simple tubular form is modified in the orbital region and the stresses are carried back to the cranium through the frontonasal articulations and the zygomatico-temporal and zygomatico-orbital "flying buttresses". If it is necessary to strengthen the upper facial skeleton, this can be done by a thickening of the bone, either throughout the circumference of the skeleton or in areas which are related to special stresses.

Fig. 3 shows a section through the facial skeleton of a young pig (about six months of age) and of an adult animal. It will be seen that with development of the dentition and growth of the face there has occurred a thickening of the bone throughout the circumference of the facial skeleton. Notice, however, that in the young animal the nasal bones, forming the roof of the nasal cavity, are already of a considerable thickness. This is related to the use of the snout for rooting purposes. The relative thickness of the nasal bone is already present in fœtal life, and at birth the sutures between the nasal and adjacent bones (*Fig.* 4) show a complicated interlocking pattern which adds strength to the skeleton. In the study of the facial skeleton of the pig from fœtal to adult life we have evidence of two important phenomena:—

1. The gradual strengthening of the facial skeleton by a thickening of the bony

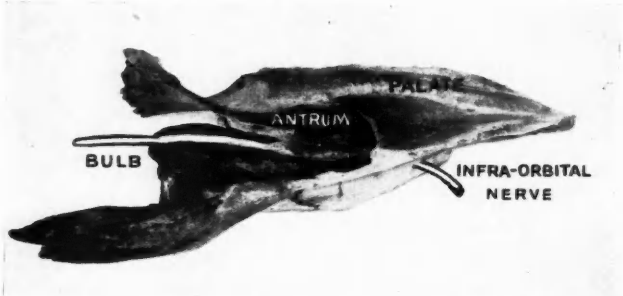

Fig. 2.—The tooth socket trough running through the nasal cavity and maxillary antrum. It ends behind in the "alveolar bulb". Note the position of the infra-orbital nerve.

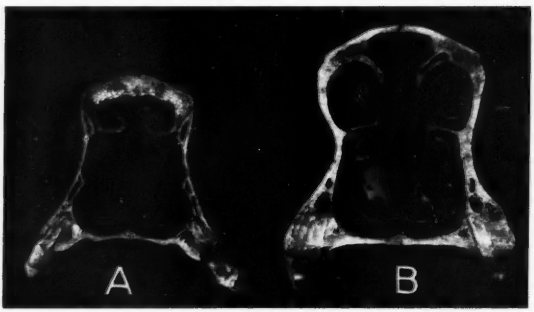

Fig. 3.—Coronal sections through the upper facial skeleton of (A) a six-months-old pig, and (B) an adult pig, to show the thickening of the bone with age.

circumference to meet the demands of postnatal function. In the nasal bones this process is more directly related to the peculiar food-seeking habits of the animal, in the bones of the hard palate to the masticatory apparatus.

2. This process, although related to postnatal function and produced by functional activity of the animal, is already foreshadowed in fœtal life prior to the onset of the individual functional stimulus. As Townsley wrote in his study of the femur (1948): "Mechanically determined structures present themselves as hereditary features in an individual,"

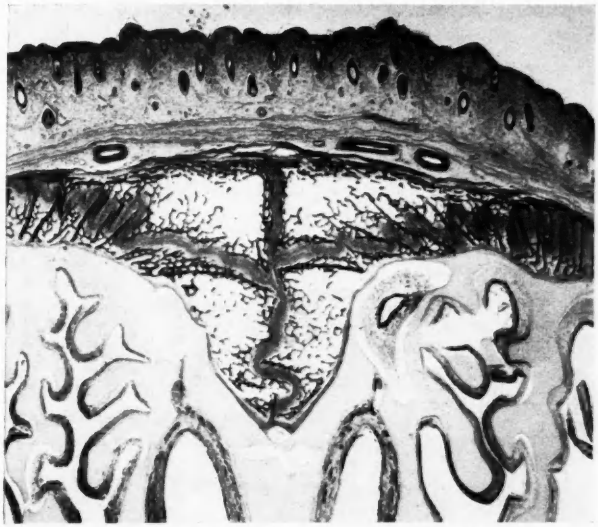

Fig. 4.—A coronal section through the frontonasal junction region of a newborn pig. Note the zig-zag structure of the sutures. (*Reproduced by permission of the Royal Society of Medicine.*)

Fig. 5 shows a section through the upper facial skeleton of a young orang-outang just in front of the orbital cavity. The section shows the socket of the second deciduous molar, the crypt of the second premolar and above this the distal wall of the crypt of the permanent canine. All these are packed between the facial and palatal surfaces of the circumferential facial skeleton to which they are united by direct cortical bony continuity or by trabeculæ of cancellous bone. With eruption of the canine and the premolars, the bone which formed their crypts will be resorbed and this region in adult animals will show a forward extension of the maxillary antrum.

Lower Jaw.—*Fig.* 6 A shows a section through the mandible of a one-month-old pig in the region of the third deciduous molar at a period when this is the most distal tooth in the arch. *Fig.* 6 B shows a section through the mandible of a six-month-old animal in the region of the first permanent molar, and *Fig.* 6 C shows a section through the mandible of an adult animal in the region of the third permanent molar. Notice again the tube-like structure of the supporting bone, and the thickening of the bone with age to meet the demands of function.

Fig. 7 shows similar sections through the lower jaws of a lion (A), a donkey (B), and an ox (C). *Fig.* 7 D shows a section through the lower jaw of an ox in the edentulous region between the incisor-canine and cheek tooth series. It has the typical form and structure of a long bone. It will be seen that the attachment of the teeth involves a breaking of the

continuity of the tubular form of the bone, and that the tooth sockets are "slung" within the tube and "attached" to it along the alveolar margins, and by cancellous bone to its inner surface. There is little doubt from the study of these sections and of the upper jaw of the sheep (*Fig.* 1) and orang-outang (*Fig.* 5) as to what constitutes tooth-socket bone and what constitutes the bone which supports the socket bone. Furthermore, it is obvious that the whole of the body of the mandible responds to the demands of function by becoming thicker and stronger. In the upper part of the face the whole of the basic facial framework responds in a similar manner. Bones such as the turbinates and vomer, however, are little if at all affected by these functional stresses.

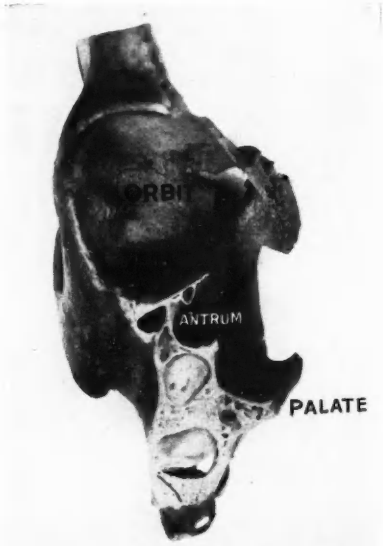

Fig. 5.—Coronal section through the facial skeleton of a young orang-outang. Note socket for second deciduous molar and crypts of second premolar and canine.

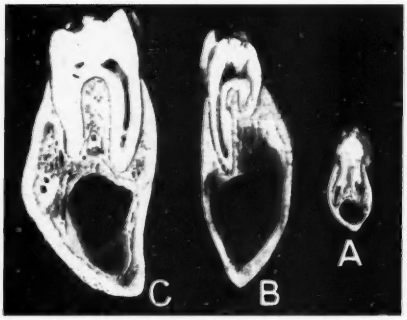

Fig. 6.—Sections through the mandible of (A) 1-month-old pig; (B) 6-months-old pig; (C) adult pig.

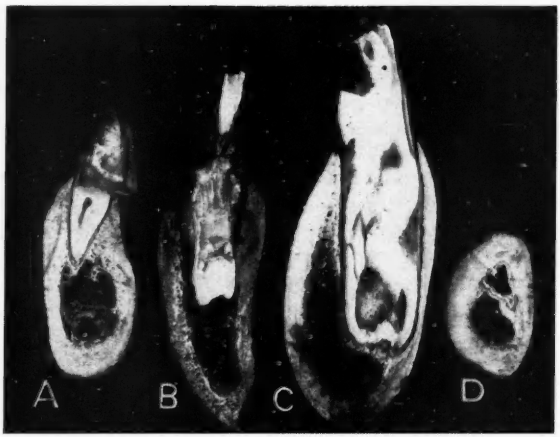

Fig. 7.—Coronal sections through the mandibles of A, a lion; B, a donkey; C, an ox, and D, through the edentulous region of an ox.

Human Material.—*Fig.* 8 A shows a section through the lower jaw of a seven-year-old child in the region of the second deciduous molar. The empty crypt of the second premolar is shown lying within the tube-like body of the mandible. In places the lamina dura of the crypt is united directly to the inner surface of the mandibular body, in other places by cancellous bone. *Fig.* 8 B shows a section through the lower jaw of an adult in the region of the first permanent molar. Here also the tooth socket is slung within the body of the bone. The body of the mandible has become thicker, especially (*a*) along the lower border, and (*b*) at the external and internal (mylohyoid) oblique ridges. There is little doubt that these areas are strengthened to meet the functional requirements of the jaw. *Fig.* 8 C shows a section from the first molar region of an edentulous mandible. Note that with the loss of the teeth the bone has returned to the tube-like structure of a typical long bone. The lower border is no longer thickened relative to the general circumference. There is no sign whatever of the tooth sockets. In returning to its basic tubular form the body of the mandible has shed all the secondary superstructures developed in relation to the dentition, and with loss of much of its function has become a less robust bone.

Fig. 8.—Coronal sections through the mandible of A, a seven-years-old child; B, an adult; C, an old person.

Fig. 9 shows sections through the maxilla of a six-year-old child and of an old adult who had lost all his teeth. In the former (*Fig.* 9 A) the crypts of the first premolar and of the canine (above) are shown lying within the facial skeleton. With eruption of the permanent teeth all the bone which formed these crypts and attached them to the facial skeleton is swept away, and the space between the orbital cavity and the permanent teeth is occupied by the maxillary antrum.

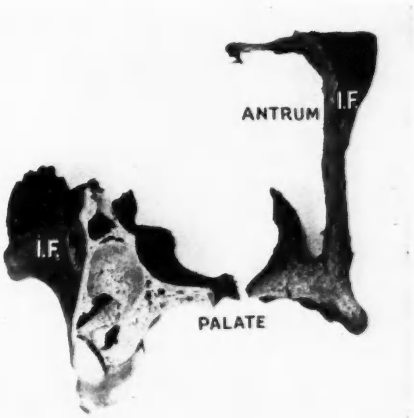

Fig. 9.—Coronal sections through the maxilla of A, a six-years-old child; and B, an adult who had lost all his teeth. Both sections are taken just in front of the infra-orbital foramen (I.F.). In the child the crypts of the 1st premolar and of the canine are seen above the 1st deciduous molar.

Fig. 10.—Coronal section through the maxilla of an old person who had lost all his teeth (in the first permanent molar region).

Fig. 10 is a section of the edentulous maxilla in the region occupied by the first permanent molar. Note the total disappearance of all dental bone and the restoration of the cortical layer of the facial skeleton beneath the gum.

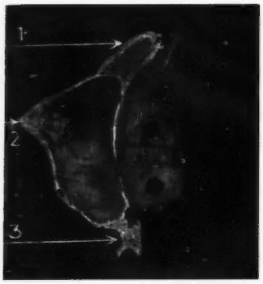

Fig. 11.—Transverse section through the maxilla of an adult showing the regions where the bone is thickened to carry the stresses of mastication. 1, Frontonasal process; 2, Zygomatic process; 3, Pterygoid plates.

Fig. 11 shows a transverse section through the middle of an adult maxilla. Note the thickening of the bone at (1) the frontonasal process, (2) the zygomatic process, and (3) the pterygoid plates. Elsewhere the bone is very thin.

DISCUSSION

"Alveolar bone" is strictly speaking a dual structure made up of the bone forming the crypts and sockets of the teeth (lamina dura of dental anatomy), and the bone which supports the sockets and tooth crypts. The "alveolar base" is merely that portion of the tooth socket which is related to the apical portions of the teeth and has no separate morphological or functional significance. The tooth sockets and crypts are slung within the upper facial skeleton and within the lower jaw; they may project into spaces within these parts such as the nasal cavity, maxillary antrum, or the medullary cavity of the mandible. Tooth sockets are always continuous with the non-dental skeleton at the alveolar margin, and may be united by continuity of cortical tissue or by trabecular lamina to other interior surfaces of the non-dental skeleton. Dental bone, strictly speaking, is related to either periodontal membrane or the follicles of developing teeth. The gum covers non-dental bone, but non-dental bone whose function it is to support the sockets of the teeth in their turn. To this socket-supporting region of the facial skeleton

Fig. 12.—Skull showing facial sculpturing in relation to the roots of the teeth.

the name "sustentacular bone" may be properly applied. It is continuous with, and in no way differs from, the bone of the facial skeleton, the only morphological difference being that sustentacular bone is covered by the muco-periosteum of the gum. As a result of a strictly functional analysis, the dentofacial skeleton may, therefore, be divided into the following parts:—

1. The teeth.
2. The periodontal membrane.
3. The bone of the socket (dental bone); also the bone lining crypts and alveoli during development of the teeth (dental bone).
4. Sustentacular bone—which supports the bone of tooth sockets, crypts, and alveoli.
5. The bone of the facial skeleton (basal bone). Dental bone and sustentacular bone together form the alveolar process of the jaws.

It should be emphasized that increased functional activity of the masticatory apparatus involves changes in all these structures, dental bone, alveolar bone, and also to a special degree certain regions of the facial skeleton (lower border of mandible, palatal arch, buttress system of the upper face). All these parts of the facial skeleton are strengthened to meet increased functional demands. The strengthening process is twofold: (*a*) an increase in the quantity of bone, and (*b*) a

reorganization of the internal bony structure (Haversian systems, trabeculæ, etc.) (Seipel, 1948; Tappen, 1953).

While it is true that the form of the face (including the alveolar arches and palate) is probably to a predominant degree genetically determined, so that it would be unwise, for example, to attempt a change in the form of the dental arches, there appears to be little evidence to support the idea that the facial skeleton (basal bone) cannot be influenced by orthodontic methods if such methods include improving the efficiency and functional activity of the dentition. *Fig.* 12, which shows the facial region of a Papuan skull, is of interest in this connexion. Notice the manner in which the tooth sockets stand out on the facial surface of the maxilla beneath their covering of alveolar bone. In the case of the first molar the buccal roots are uncovered. As this is an adult skull the condition must have been a stable one of some years' duration. Such a condition, which is most often found in older skulls, is probably related to a reduction of masticatory efficiency with age, with a secondary resorption of unnecessary bone. The tide of bone deposition, which reaches its height at the onset of adult life, retreats towards the grave, leaving the dentition where it was carried during the height of its functional activity.

SUMMARY

The facial skeleton has been analysed in its relation to the dental apparatus. Three functional regions can be defined and demarcated: (1) dental bone, (2) sustentacular bone, and (3) basal bone. These have been discussed and it has been shown that all three regions can respond to increasing functional demands related to mastication. The term "apical base" has no morphological or functional significance.

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NOTES ON INCOME TAX

By **JOHN LYMESTER**

The dentist in employment is assessed on the remuneration which he receives under the rules of "Pay as You Earn". He is given a Code Number in accordance with the total of his allowances for the year, and every month or week, when his remuneration is paid, the applicable proportion of tax on the proportion of his total income to date, is deducted. The dentist in practice on his own account must render financial accounts to the Inland Revenue. These accounts are adjusted in respect of any items which are not allowable expenses, that is, they are not incurred wholly and exclusively for the business of his profession, and on the balance he is assessed to income tax. He is not assessed, however, on the actual income for the year, but according to certain rules.

For the normal continuing practice, the assessment for the income tax year which runs from April 6 to the following April 5, is based on the accounts which end before the commencement of the income tax year. Thus for the current income tax year which runs from April 6, 1955, to April 5, 1956, he is assessed on the accounts which end prior to April 5, 1955; this may be March 31, 1955, Dec. 31, 1953, or any other normal accounting financial year which falls in the year from April 6, 1954, to April 5, 1955.

Special rules of assessment apply in the case of a new practice. The assessments are raised as follows:—

First Income Tax Year—on the profits as shown by the accounts for the period from the date of commencement to the following April 5.

Second Income Tax Year—on the profits of the first year of the carrying on of the practice.

Third Income Tax Year—on the profits of the preceding financial year.

In many circumstances the assessments for the three years are based on the results as shown by the first year's accounts.

The taxpayer may claim to have the assessments for the second and third income tax years, that is both years, but not one only, adjusted to the actual profits of these years, if it is to his advantage.

Special rules also apply in the case of the discontinued business.

The assessment for the last year is based on the actual profits from April 6 to the date of discontinuance, and the Inland Revenue have the option of adjusting the assessment for the next to last year to the actual income of this year. They will, of course, take advantage of this right if an increased assessment can be raised.

In the case of a partnership, an assessment for the year, according to the foregoing rules, is raised on the firm's profits before any deduction of partner's salaries, wages, etc., but the actual assessment is subdivided between the partners according to the ratio in which they shared the profits during the actual income tax year.

Every individual taxpayer is entitled to certain allowances. The first is the Earned Income Relief, which is two-ninths of the earned income, with a maximum allowance of £450. A married woman in receipt of earned income is entitled also to the Wife's Earned Income Relief, which is seven-ninths of the wife's earned income, with a maximum allowance of £140. A married taxpayer gets an allowance of £240, and all other taxpayers £140.

An allowance of £100 is granted for each child who is born in the income tax year or is under 16 years of age at the beginning of the tax year, or if over that age is receiving either full-time educational instruction, or undertaking vocational training. In every case, the child's income must be less than £85 a year. An allowance is also granted for adopted children if they are in the care of, and maintained by, the taxpayer.

An allowance of £60 is granted if the taxpayer maintains his widowed mother, or mother-in-law, or any other relative, who through old age or infirmity is unable to earn a living. The allowance is reduced by any income which the dependant has in excess of £105 per annum, and consequently, if the relative has income of £165 per annum, no allowance is granted.

An allowance for a housekeeper is granted if the taxpayer is a widow, or widower, or being a married man is forced to employ a housekeeper to look after his children and he proves that his wife is incapable of so doing, because of physical or mental infirmity.

After the deduction of these allowances, income tax is payable. The standard rate of income tax is eight shillings and sixpence in the pound, but Reduced Rate Relief is granted whereby the first £60 of taxable income only pays tax at two shillings and threepence in the pound, the next £150 only pays tax at four shillings and ninepence in the pound, and the next £150 at six shillings and ninepence in the pound. This Reduced Rate Relief is granted to both husband and wife if the wife has earned income liable to tax.

Relief is also granted in respect of premiums on policies of life assurance on the lives of either the taxpayer or his wife, subject to conditions that the premiums must not exceed one-sixth of the total income or 7 per cent of the sum assured at death. The relief is normally two-fifths of the premiums if they exceed £25.

Finally, in the accounts submitted to the Inspector of Taxes, all expenses incurred wholly and exclusively in the course of the business should be claimed. This will include all the normal expenses, but not any personal or private drawings of the dentist or his partners.

Depreciation of machinery and plant, which includes motor cars, is not allowed, but in lieu thereof, wear and tear, including the Investment or Initial Allowances and Balancing Allowance, can be claimed.

THE PHYSIOLOGY OF MASTICATION*†

By **D. J. ANDERSON**, Ph.D., M.Sc., B.D.S.
*Physiological Laboratory, Guy's Hospital Medical School, London, S.E.*1.

MASTICATION is the mixing of the food with the saliva and its reduction to a size and consistency suitable for swallowing. The role of the teeth in this sequence of events is to transmit to the material being chewed the forces exerted by the muscles of mastication. The hinge movements, the forward and lateral movements which are made possible by the structure of the condylar articulation, allow these forces to be deployed where necessary. Initially force is transmitted through the anterior teeth in cutting off the mouthful, later through the posterior teeth in grinding and crushing the food. The limits to the movements occurring during mastication are set partly by the soft tissues of the mouth and the structure of the condylar articulation, but also, when the teeth are close to centric occlusion, by the inclined planes of the tooth surfaces.

With specially chosen soft or semiliquid food it is possible to reduce the role of the masticatory machinery to that of a mixing apparatus, but even with the present-day diet some structures capable of transmitting force from the jaw muscles to the food are necessary either in the form of natural or artificial dentures. In the last analysis, therefore, mastication means the application of force and it seems logical when studying the physiology of mastication to give pride of place to an investigation of the forces involved.

Many people, starting with Johannes Alphonsus Borellus (1680), have measured the maximum biting force of which the masticatory apparatus is capable. Borellus employed the simple technique of hanging weights by a cord across the molar teeth. He calculated that the maximum power of the jaws was approximately 500 lb. Many investigators have devised more complex methods of measuring maximum biting power and it is appropriate to refer to a past president of this society, Sheldon Friel (1924), who measured maximum biting forces in children, and attempted to correlate these and other mouth forces with other measurements of developmental progress such as height, weight, and hand-grip force. With mastication, as with many other movements, the potential of the muscles greatly exceeds the actual forces employed in everyday activities, and these measurements of maximum biting power give little indication of masticatory forces. The difficulty so far has been to produce a measuring technique which allowed mastication to take place unhindered, and the technique which was reported in a previous paper (Anderson, 1953) is the first which allowed unhindered mastication with the natural dentition. I propose to give a brief outline of this method and also to indicate modifications which have been made since then.

The method depends on the use of the resistance wire strain gauge. This is a device which consists of a coil of resistance wire attached to a fairly rigid resin-impregnated paper backing. When the coil is stretched or compressed, the resistance changes and over a certain range resistance change and dimensional change are related in a linear fashion. The resistance change can be recorded with a simple Wheatstone bridge circuit and a suitable recording instrument such as a galvanometer or cathode-ray oscilloscope. If a strain gauge is firmly fixed to a structure being subjected to loads, then the resulting dimensional change in the structure being transmitted to the strain gauge will cause a resistance change which provides a highly sensitive index of the dimensional changes in the structure under load. In adapting this device to the measurement of masticatory loads the strain gauge is attached to a suitably

* Some of the observations reported in this paper form part of a thesis for the degree of Ph.D. at the University of London.

† Given at the meeting of the British Society for the Study of Orthodontics on January 10, 1955.

supported metal bar which can be reversibly distorted by masticatory loads. By the application of known loads to this metal bar outside the mouth it is possible to construct a calibration graph relating the applied loads to the resistance change on the Wheatstone

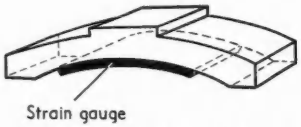

Fig. 1.—Strain gauge unit shown diagrammatically.

bridge circuit, as indicated in this case by the deflection of an oscilloscope beam. Then, observation of the deflections produced by forces inside the mouth allows the determination of these forces by reference to the calibration curve. The most important demand to be made of any apparatus constructed on these lines is that it shall be small enough to be accommodated either in a cavity in an existing natural tooth or in an artificial tooth. The apparatus must allow unhindered movements and occlusion, and must be capable of responding at the frequency of the masticatory movements.

Strain gauges of dimensions 2 mm. × 3 mm. have been made specially for this investigation at the National Physical Laboratory and the supported metal bar is constructed of silver steel in the form of an arch with a central platform. The strain gauge is firmly attached to the under-surface of the arch by means of phenol-formaldehyde resin. The whole structure, as shown in *Fig.* 1, has dimensions of about 5 mm. × 3 mm. × 3 mm. high. A suitable cavity is prepared in a live tooth and an inlay constructed in which an oblong vertical-sided cavity is cut to take the strain gauge unit. In addition the upper edges of the cavity in the inlay are cut back to form a ledge of about 1 mm. in depth and variable width. Where convenient, pits are sunk from this ledge into the substance of the inlay, and with the strain gauge unit in position a second wax pattern is prepared for an inlay to occupy the ledge and pits and cover the strain gauge unit with the exception of its central platform. When this inlay is cast, its under-surface is freed of contact with the gauge unit by grinding. It is a removable inlay placed in position after insertion of the gauge unit and held in position simply by its downward projection—sometimes a little zinc oxide paste was used to help its retention. Its function is to protect the gauge unit from the biting forces except in the central portion. The whole apparatus in situ is shown in *Fig.* 2. Leads from the strain gauge are made of fine copper wire covered with enamel and cotton impregnated with resin. The leads leave the strain gauge tooth through a convenient hole in the main inlay mesially or distally on the lingual side. They then pass along the lingual side of the jaw to leave the mouth through a suitable lower incisor interdental space. The leads are protected from engulfment during mastication by a very thin plastic plate which is applied to the lingual side of the lower arch.

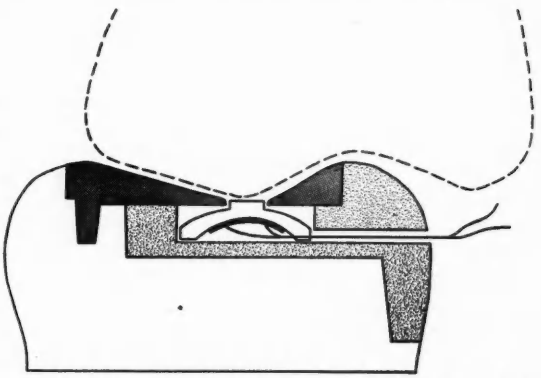

Fig. 2.—Diagram of the strain gauge unit in situ. The lightly shaded area represents the permanent inlay, the darkly shaded area represents the temporary covering inlay.

This apparatus has been constructed for six subjects and at present results are available from four of these. The first experiments have been simply to study the loads obtained when chewing three different types of food. The first was a fairly hard biscuit of a texture similar to a ginger nut but not as hard. With this biscuit, movements of the jaws without

any force being applied are sufficient to bring about dissolution of the material in the saliva. Force is therefore not essential, although it is customary to use it rather than wait for the biscuit to break up in the saliva. With the other two materials, carrot and meat, solution in the saliva is a very small contribution to the preparation for swallowing, and force must be applied. It was hoped by using the same batch of biscuits throughout and relying on uniformity of carrot and meat to provide three test materials with which comparison could be made between the four subjects of the investigation. However, this was not to be, since it was found at an early stage that the carrot varied considerably in texture and we were forced to use different kinds of meat with considerable variations in tenderness.

Examination of individual records, examples of which are shown in *Fig.* 3, reveals certain characteristics. First the loads recorded towards the end of the sequences are in most cases greater than at the beginning, and in some the last one or two thrusts are larger than the rest, more prolonged and separated from the rest by more than the usual interval. There are several possible explanations of the increase in loads towards the end of the sequence. The most obvious is, of course, that the subject is increasing his muscular activity, but this is not the subjective impression, not that I attach a great deal of importance to subjective impressions. The second possible explanation is the one which seems more likely. The apparatus records only the vertical component of the total force applied. In the early stages when the piece of food is large, the application of force breaks the large piece into several small pieces which are driven laterally. This must mean dissipation of the force laterally, with a consequent reduction in the vertical component. When the material is reduced to smaller pieces less resistance is met by the jaws as they move together through the mass of food—pushing some of it laterally, and the vertical component is therefore a bigger fraction of the total than before. The recorded loads never exceed 8–10 kg.

The second point to be observed in the tracings is the swallowing thrust. This is particularly well marked in two of the subjects, not so frequently or clearly in the third, and hardly noticeable in the fourth.

Measurements of loads recorded on a few square millimetres of gauge unit platform cannot give any direct indication of the loads on the whole tooth. It is a weakness in the method that it does not allow such direct measurements to be made, but such a weakness is unavoidable unless the recording device is arranged to record from the whole occlusal surface of the tooth. This would mean that the entire crown would be sacrificed and the application of a method requiring such a large part of the tooth would be restricted almost entirely to dead teeth. Since the recording device only samples the load from a small chosen area of the tooth any calculation of the total must be based on assumptions and therefore can never arrive at an indisputable answer. The assumptions which are made are first, that the distribution of load is uniform over the whole occlusal surface of a tooth, and second, that the surface which takes the load is the surface which is in contact with the opposing teeth in centric occlusion. Instead of calibrating the strain gauge by directly applying the loads to the platform,

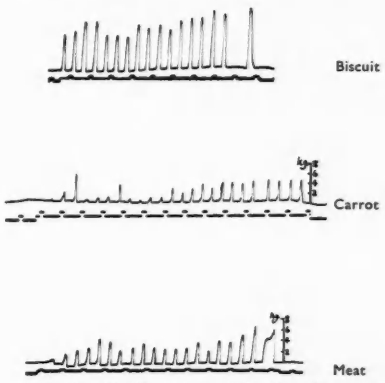

Fig. 3.—Oscilloscope records taken during chewing sequences. The upper tracing is the strain gauge response; the calibration scale has been inserted for convenience of reading. The lower tracing is deflected upwards at one-second intervals and is raised bodily for the duration of the chewing sequence.

the method is now altered so that the strain gauge unit is calibrated in a model of the tooth and the load is applied through a model of the opposing teeth, with opposing surfaces correctly articulated. Comparison of the two curves obtained by the direct and whole-tooth calibration showed, in one case for example, that whereas a load of 4 kg. applied directly to the strain gauge and taken in entirety by the strain gauge gives an oscilloscope deflection of 7 mm., the same load, when applied to the gauge unit in situ, and shared between the gauge platform and the other contact areas, gives a deflection of 3·6 mm. only. The use of the method of whole-tooth calibration gives a very close approximation to the actual loads taken by the tooth. The reason it is not claimed that the method gives the true loads on the tooth is because separation of the teeth by food must mean that the area bearing the thrust will now be slightly larger, since the intervening food will to some extent fill in the fissures and make them load-bearing areas. Unfortunately this method of approaching the true tooth loads was only developed at a late stage in the investigation when two of the subjects were no longer available. However, in the remaining two, by means of the double calibration, it was possible to relate the whole-tooth and direct calibrations by a factor which in the case of L. V. H. was 1·9 and D. J. A. was 2·8. Recalculation of the figures on this basis gave results which must be close to the truth in these subjects.

The results from the two subjects D. J. A. and L. V. H. have been presented in two ways: First the loads applied at each thrust have been added up and expressed as a whole-tooth load for every chewing sequence. This represents the total force applied to the food between the teeth concerned. It will be seen in the case of biscuit and carrot that these are not significantly different in the two subjects (*Tables I, II*). With meat, however, the total load applied by D. J. A. averaged only 66·5 kg. compared with 134·0 kg. by L. V. H. Since the loads vary so much during individual chewing sequences, a determination of the mean load per thrust would be of little value. I have therefore taken the largest thrust out of each sequence and calculated the mean for the series of twenty sequences in both subjects for the three foods. These results show that in L. V. H. the mean maximum does not vary significantly whatever the food. In D. J. A. the maxima are not significantly different with biscuit and carrot, but the meat value is significantly different from the others. With carrot D. J. A. and L. V. H. apply maximum loads which are not significantly different, but with biscuit and meat the values are different, D. J. A. applying a higher maximum on biscuit than L. V. H. and a lower maximum on meat than L. V. H.

Table I.—Mean Total Whole-tooth Loads per Chewing Sequence

	Subject D. J. A.		*Subject L. V. H.*	
	Load kg.	σ (*standard deviation*)	*Load* kg.	σ (*standard deviation*)
Biscuit	138·1	± 31·9	142·2	± 19·8
Carrot	149·4	± 20·3	160·1	± 79·4
Meat	66·5	± 21·0	134·0	± 47·6

Table II.—Mean Maximum Whole-tooth Loads from Twenty Sequences

	Subject D. J. A.		*Subject L. V. H.*	
	Load kg.	σ (*standard deviation*)	*Load* kg.	σ (*standard deviation*)
Biscuit	14·9	± 3·02	11·4	± 1·24
Carrot	13·7	± 1·60	12·0	± 3·01
Meat	7·2	± 1·27	11·6	± 2·58

These load patterns represent the end-result of the highly co-ordinated activity of the muscles of mastication, and in the few subjects examined so far seem to show individual characteristics. The co-ordination of these complicated movements provides an interesting physiological study. Since quite large forces are involved even in chewing ordinary materials, the movements are not executed without some danger to the soft tissues of the mouth. The problem is not simply one of keeping the cheeks and tongue out of the way —these structures have the perilous function to perform of keeping the occlusal surfaces of the teeth supplied with material as the jaws come together. The co-ordination of the very complicated movements of the jaws and associated soft parts depends on accurate information from the parts concerned. To take a simple example of a muscle movement,

such as flexion of a joint, its accurate and smooth execution requires a background of nerve impulses from receptors in the muscles which act on the joint, from receptors in the tendons of these muscles, and from the joint itself. Surface receptors may contribute if the movement results in a change of relationship between the limb and its tangible environment. These impulses pass to the higher centres in the brain and it is upon their constantly changing pattern that the precision of movement depends. So it is in the mouth; receptors in the masticatory muscles and their tendons, in the tongue and surrounding soft tissues, and in the joint must all contribute. In addition, however, there must be some means whereby the force of the masticatory movements is regulated, and it is certain that receptors around the teeth contribute towards this. Pfaffman (1939) using the cat and Ness (1954) using the rabbit have recorded impulses from the inferior dental nerve when pressure is applied to the teeth. It is not known whether these receptors play an important role in mastication, but in the records I have shown we have a picture of the results of masticatory movements, pictures characteristic of the individual and the food being chewed. By procedures such as selective anæsthesia a method is available for testing the importance of the contribution of the periodontal receptors to the masticatory picture while leaving the contribution of muscle and tendon receptors unaffected. So much for the purely physiological extension of this technique in the study of masticatory movement.

Like biting forces, the movements of mastication have been investigated by many workers, especially those concerned with the shape and disposition of artificial teeth. X-ray photography, cinefluorography, mechanical tracing devices, and various photographic techniques have been employed. As with masticatory forces so with movements, the difficulty has always been to find a method which does not interfere with the movements being studied. It seems to me that the most interesting part of the movement is when the teeth are in or near contact. Hildebrand (1931) has made one of the most comprehensive studies of the masticatory movements and concludes that there is some slight lateral movement at the beginning and end of the movement and that there is gliding of the teeth of the lower jaw against those of the upper in some cases. There is also gliding in a sagittal plane before the opposing teeth meet. Although Hildebrand does not say so, his results suggest that centric occlusion or something very close to it is reached at the termination of most chewing thrusts.

Jankelson, Hoffman, and Hendron (1953) also made studies of masticatory movements using cinefluorographic methods. He also records lateral movement with the teeth closely related, but does not consider the path of these small lateral movements to be determined by the occlusal planes of the teeth since he found actual contact between the teeth during chewing to be rare. Tooth-to-tooth contact was recorded by using subjects who had metal crowns on posterior teeth. Wires were attached to the upper and lower crowns and contact was recorded by a simple electrical circuit which operated an ink recorder on a moving paper. He shows records of one subject eating apple and in this contact is only achieved at the end of the sequence during swallowing.

Yurkstas and Emerson (1954) recently studied the problem of tooth contact during chewing in 12 patients with artificial dentures. They recorded from both sides of the mouth and found, rather surprisingly, that when the subjects chewed a bread and corned beef sandwich, all of them achieved contact on the working side for part of the sequence, some made contact at every thrust, others but rarely. On the balancing side, however, they record that almost all subjects showed contact at every thrust. In neither Jankelson's nor Yurkstas's investigations is any attempt made to differentiate between the contact which might be achieved in a balanced occlusion during lateral excursion and centric occlusal contact.

Picton and I have started an investigation into the question of tooth-to-tooth contact in centric occlusion during chewing. The first series in the study has been carried out on

myself. My strain gauge apparatus is in $\overline{|6}$. The $\overline{6|}$ tilts forwards owing to the failure of the $\overline{5|}$ to erupt. An occlusal filling has been removed from this and a removable inlay has been prepared for it, the occlusal surface of

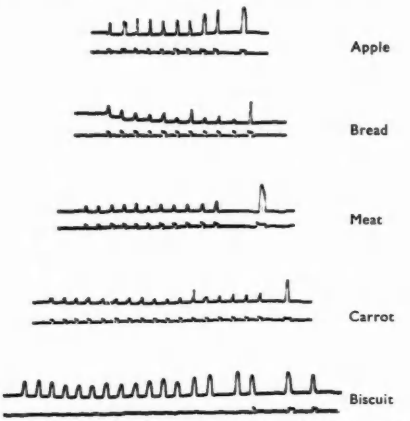

Fig. 4.—Oscilloscope records of strain gauge responses and tooth contact marking device during the mastication of five different materials. The upper tracing in every case is the strain gauge record. The lower tracing is deflected upwards when the teeth come into contact.

the inlay raised well above the occlusal surface of the tooth in the form of a narrow ridge about 1 mm. wide which runs anteroposteriorly and occludes with a three-quarter crown on the $\underline{5|}$. The $\overline{6|}$ inlay has a wire lead attached to it and is temporarily stuck in place with oxyphosphate cement for the duration of an experiment. A hole has been drilled in the $\underline{5|}$ three-quarter crown to accommodate a second lead during the experiment. The leads form part of a simple circuit supplied with 1·5 volts and connected to the lower beam of an oscilloscope, the strain gauge supplying the upper beam. The bite has been most carefully adjusted and the narrowness of the contact ensures that only slight movement out of centric occlusion laterally breaks the contact. Some records are shown in *Fig.* 4. The strain gauge records are shown on the upper tracing in each record and upward deflection of the lower beam indicates contact on the right side. It can be seen that with biscuit, contact is only achieved towards the end of the sequence, the last one or two thrusts, and the swallow. With all the other materials, however, contact is achieved at every thrust. I have tried to separate the teeth on the left while maintaining contact on the right and found that it is almost impossible. It therefore seems fair to assume that these records mean that centric occlusion is achieved.

In this account an attempt has been made to show how the application of modern techniques may help to establish fundamental facts of the processes of mastication. The volume of results from the strain gauge and tooth contact investigations is not yet sufficient to provide a firm basis for general conclusions.

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DISCUSSION

Mr. C. F. Ballard, in opening the discussion, said that, although it was usually regarded as the duty of the opener of a discussion to criticize the paper in order to stimulate discussion, it was very unwise for a clinician to attempt to do so in regard to the research work of a physiologist, anatomist, or biologist. Such research workers, however, must realize that much of their work was very narrow, and if it did not immediately fit in with a clinical observation they must not accuse the clinician of being wrong, particularly if other research supported the clinician. On the other hand, they should not give up their research if it appeared to have no immediate clinical application, as much and perhaps most of the really valuable work that had been done had been the result of following up a train of thought, perhaps even a subconscious train of thought.

Orthodontists were interested in oro-facial behaviour, and it was their duty to attempt to correlate the work of neurophysiologists, muscle physiologists, and perception physiologists, so that they had a more scientific understanding of their problem. He admitted that at the

present stage he did not see the significance of Dr. Anderson's work on the pressures of mastication, except that it illustrated that there were similarities of pattern for each individual. He was sure that Mr. Tulley would be able to speak in a much more significant way than he himself could do in this respect.

Strain gauge pressure work had been going on in Boston for some years, and it had been well under way when he was there in 1950.

He proposed to sum up the question of pressures as he saw it clinically, for Dr. Anderson's consideration.

In spite of the work of Smith and Storey, who used enormous pressures, it was known that a pressure of 25 g. or less applied to a tooth would stimulate its movement and that this movement would continue, if there was no soft tissue or cuspal interference, until the spring was passive—in other words, at the end of that tooth movement the pressure was no more than a gramme or two. That was one of the reasons why orthodontists had to accept the statement that the dento-alveolar structures, whether normal or abnormal, were in balance in soft-tissue behaviour, except when there was obvious traumatic occlusion. It was because teeth were so easily stimulated to move, and because it was known from clinical observation that soft-tissue behaviour determined the position of the dental arches, that he could not accept Dr. Anderson's statement that centric occlusion was determined by the inclined planes of the tooth surfaces. He was not attributing this statement directly to Dr. Anderson; it was a generally accepted one which he thought was entirely wrong and it led to many misconceptions.

In his opinion, a good deal of recent research into the origin of motor activity supported the view that the rest position was endogenously determined and that the path of closure to centric occlusion was likewise endogenously determined. Weiss, as long ago as 1925, had stated that co-ordinated movements were the result of organized patterns of muscle combinations which produced the movements of the joint and that those organized patterns were relatively stable elements. Weiss had stated quite firmly that there was a hierarchal organization of these patterns of activity and that, though normally reinforced by proprioceptive reflexes, they took precedence over the latter in conflicting circumstances. He had not time to refer to the further research work which supported that view, but the clinical implications were that, if pressures of the order of a gramme or two could move teeth, not only should centric occlusion be a position in which the dental arches were in balance in soft-tissue behaviour but this position should be the same as that determined by the path of closure of the mandible. In other words, cuspal inclines only contributed to the alinement of the teeth during eruption. There were, however, cases in which there was traumatic occlusion as the result of cuspal interference in the path of closure; secondly, there were cases of resorption of roots of the teeth and thickening of the periodontal membrane when in fact they were not in traumatic occlusion; and, thirdly, there were the types of mandibular displacement which Grewcock and he had attempted to analyse clinically and physiologically in their Eastbourne paper.

The probable physiological mechanism of the last type of case must be understood before the other types of case can be analysed. Grewcock and he had postulated in their Eastbourne paper that there was a true endogenously determined path of closure for each individual, and that, if the cusps of two opposing teeth or several opposing teeth met at an angle which produced abnormal stresses in the receptor organs in the periodontal membrane, then in cases of mandibular deviation there was a reflex mechanism to take the mandible away from this abnormal contact relationship. Dr. Anderson had referred to the work of Pfaffman and Ness. In other words, there was within the individual the potentiality for developing a habit movement as a protective mechanism which superseded the endogenous movement. It was well known in physiology that such habit movements needed continual afferent stimuli for their maintenance, and Grewcock and he had pointed out that, clinically, if the opposing cuspal inclines which produced the afferent stimuli were removed the individual reverted within a few hours to the normal path of closure, forgetting the habit movement. If cuspal contact was made, it was probably an abnormal one in the majority of masticatory movements. In this connexion he would like to ask Dr. Anderson whether he was quite certain that in some of his recordings his strain gauge was not high on the bite.

Traumatic occlusion cases, therefore, were those in which, for some reason or other, there was not this protective reflex activity, and in which the teeth could not move as the result of these occlusal stresses into a new position of balance. In other words, the position of these traumatized teeth at centric occlusion was not the same as the position within the soft-tissue behaviour of lips, cheeks, and tongue. They were jiggled between the two.

The cause of this traumatic condition must be the result of a sum total of forces rather than a maximum force which Dr. Anderson had been measuring, these forces being applied in an abnormal direction. It seemed to him that if Dr. Anderson could in some way or other measure the sum of these forces over any period, say twenty-four hours, it would enable these pathological conditions to be understood more fully.

There was another type of trauma which came into the same category, being produced entirely by soft-tissue activity. It was not at all uncommon to find that, in cases of very vigorous tongue thrusting behaviour, the roots of the upper incisor teeth were resorbed and the periodontal membrane was thickened. There was an open bite because of this tongue-thrusting behaviour, and it therefore seemed to him that the only possible explanation was that the sum total of the forces applied by the tongue, and by the lips to resist the tongue thrust, were such that they stimulated the activity which produced the thickening of the periodontal membrane and resorption of the apices of the teeth. The teeth must be in equilibrium because they did not move.

Mr. Ballard hoped that Mr. Anderson would forgive the apparent irrelevance of some of what he had said, but it did appear to come within the scope of the title of the paper—"The Physiology of Mastication".

Mr. W. J. Tulley said he thought that a great deal of important information could be obtained by combining Dr. Anderson's studies with the electromyographic analysis of the chewing pattern. He realized that Dr. Anderson had the problem of finding suitable material, as inlays had to be inserted to carry the strain gauges.

In the studies of chewing movements that he had made with the electromyograph taking records from the masseter and temporalis, it had been found that there was not a great deal of difference in action potentials in the chewing of different foodstuffs. There was, however, considerable individual variation of general pattern and

he hoped to be able to relate these patterns to different types of occlusion. He would like to ask Dr. Anderson whether he had examined the total force which his subjects could exert per square millimetre when their teeth were in centric occlusion.

Mr. R. D. Emslie said he had heard the suggestion made that a "Journal of Traumatic Occlusion" should be started, as such a journal could publish a great many theories and present a great many facts without any proof whatsoever. Having heard Dr. Anderson's paper, he was afraid that this journal, if started, would probably have a very short life.

Mr. A. W. Eastwood said it had occurred to him that the chewing habits of the individual concerned might have some effect in Dr. Anderson's experiments. He himself was supposed to have a normal occlusion and his bite was mostly well balanced, but if he was eating a tough piece of meat he chewed it on the left side, whereas when he was eating something soft he chewed it on both sides. As far as the interdigitation was concerned, it conformed completely to Angle's Class I.

Mr. L. H. Schuler asked whether Dr. Anderson proposed later on to to make his masticatory experiments on orthodontic cases. He thought that, if so, Dr. Anderson might first take measurements of a number of normal cases, say from the age of 7 to 15 years, and then take measurements of other cases requiring orthodontic treatment, to see whether these, and cases with various abnormal swallowing actions, were unable to exert similar pressures on the bite gauge and whether after treatment, they were able to exert different pressures; in other words, whether the ability to masticate improved after orthodontic treatment.

The President asked whether Dr. Anderson could say what was the Angle classification in each of his cases.

Dr. D. J. Anderson, in replying to the discussion, said that the clinical application had not been his first object when he started his work. He took his stand on the statement that, since mastication meant the application of force, it seemed logical, when studying the physiology of mastication, to give pride of place to an investigation of the forces involved.

In reply to Mr. Ballard, he would say that the strain gauges had not been high on the bite. He had only the subjects' impressions on that point, but he thought that was a fair method of assessing the correct state of affairs.

He did not understand all that Mr. Ballard had said about traumatic occlusion. He did not know whether the teeth came into contact during chewing. He knew that in his own mouth the $\overline{6}|$ and the $|\overline{5}$ came into contact during chewing, but he could not say anything definitely about the other teeth in his mouth, though he could hazard a guess. He could not say anything about other people yet, and, as far as he knew, there were not many people who could say much more than that. He would have thought that it was essential to find out whether the teeth came into contact or not during chewing. If they did come into contact and if there was lateral movement before or after contact, it seemed to him that it was likely (he proposed to investigate this) that the path of the lateral movement might be determined by the shape of the cusps of the teeth. That could be discovered, he thought, by gradually making the very narrow contact in the lower arch much wider and seeing whether the duration of the contact indicated by the width and the elevation of the base line increased or not. If it did increase, one could assume that, by providing a larger surface of contact on the lower marker, the teeth were in fact gliding surface to surface during the initial or the last part of the movement, whichever it happened to be.

With regard to Mr. Tulley's question, he had not determined the maximum force. He had obtained his gauges so far free of cost, and he had therefore been a little careful of them. He had always wanted to get results with the food that was used at the time, and he had therefore been very cagey about deciding the limits of the experiment. However, he was now making his own gauges, so he might be able to be more liberal with them.

As far as applying his work to orthodontic cases was concerned, his best source of subjects was at the moment dental students doing a physiology course, and they ranged from 18 to 21 or thereabouts. He could not say whether they would become orthodontic cases or not. He always had models of the subjects. He did not think there was much prospect of applying his work as it stood to anyone except those people who were most readily available, but certainly information could be obtained about their orthodontic state.

With regard to Mr. Eastwood's remarks, unfortunately the subject was limited to chewing on one side, the side where the strain gauge was.

Finally, with regard to Mr. Pringle's question on the orthodontic classification of his cases. As far as he knew, his own classification was Class I and he thought the other subject's also was Class I.

SOCIETY NOTES

B.S.S.O. COUNTRY MEETING AT SHEFFIELD

FOLLOWING a request by members, the British Society for the Study of Orthodontics held its first Country Meeting at Sheffield on May 6 and 7 under the Presidency of Mr. K. E. Pringle. Lectures and demonstrations were held at the new Charles Clifford Dental Hospital at the kind invitation of Professor Roberts and with the permission of the Governors of the hospital. The meeting was very well attended, over 100 members were present, and there was a really representative gathering of practitioners and teachers from all parts of the British Isles. Mr. Harold Chapman, a founder member of the Society, and Professor Sheldon Friel were especially welcome.

Mr. Gardiner and the staff of the Dental Hospital at Sheffield are to be congratulated on the organization which led to the smooth running of the Congress. The University Staff Club very kindly gave members facilities for meals and refreshments. The Congress was opened by Professor Roberts with an address

of welcome. He said that he was pleased to see that a large number of people from the South had come to the Congress. He thought that there should be an increasing interchange between the provincial Dental Schools and those in London.

During the meeting the following papers were given and these will be published in the DENTAL PRACTITIONER in due course:—

Friday morning:—

Mr. J. R. E. Mills: "Ideal Dental Occlusion in the Primates".

Mr. H. L. Leech: "Restorative Treatment of Anodontia in a Developing Child".

Friday afternoon:—

Mr. W. A. Nicol: "The Relationship of the Lip-line to the Incisor Teeth".

Mr. D. T. Hartley: "The Clinical Assessment of the Unerupted Maxillary Canine".

Mr. S. G. McCallin: "Angle's Class III Malocclusion".

Saturday morning: Symposium on the Temporomandibular Joint and Mandibular Movement:—

Mr. R. Sprinz: "The Mandibular Joint. Anatomical and Functional Considerations".

Mr. J. Hopper: "A preliminary Investigation of Mandibular Guidance in Postural Class III Cases".

Mr. C. F. Ballard: "A Consideration of the Physiological Background of Mandibular Posture and Movement".

The discussions were lively and were only limited by the time factor. The following demonstrations were given on the Saturday afternoon:—

Mr. J. Campbell: "Apparatus for Testing the Theory of Constancy of the Mandibular Rest Position".

Mr. D. F. Glass: "Some Variations on a Scheme by Andresen".

Mr. T. D. Hartley: "An Orthodontic Teaching Model".

Mr. A. G. Huddart: "A lingual Appliance for Mesiodistal Tooth Movement".

Miss R. Sclare: "Heredity".

Mr. B. R. Townend: "Incisor Band-making Pliers".

Mr. H. G. Watkin: "A new Latch for the Pin and Tube Appliance".

Mr. R. Sprinz: "The Mandibular Joint".

Mr. P. H. Burke: "Eruption Analysis of Maxillary First Incisors in a Patient with Unilateral Absence of Second Incisor".

Prof. G. E. M. Hallett: "Negroid and Other Lateral Skull Radiographs of Unusual Interest".

Mr. G. B. Hopkin and Mr. J. D. McEwen: "The Application of a Palatographic Technique to some Orthodontic Problems".

Mr. W. H. Littlefield: "Examples of Treatment".

Mr. E. K. Breakspear: "Auxiliary Springs for Retraction of Canines".

Mr. H. L. Eirew: "The Construction of the Bimler Appliance". "A Modified Reverse Andresen Appliance".

Mr. A. W. Greenwood: "Upper Incisor Proclination in Some Patients with Mandibular Prognathism".

Mr. D. Logie: "A Removable Appliance Retained without Clasps". "A Lower Lingual Arch with a New Type of Attachment".

Mr. T. Jason Wood: "Caretaker Appliances".

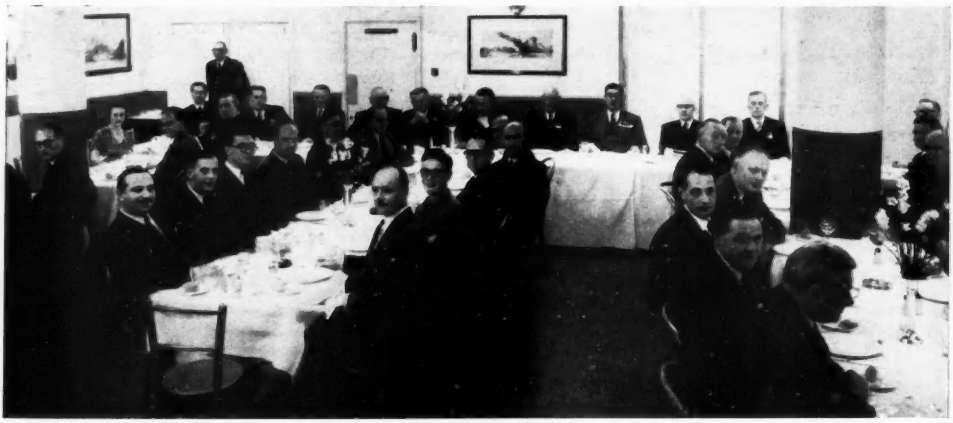
Attendances at these demonstrations were especially keen and provided interest for the clinician, teacher, and the research worker.

Despite the full professional programme, a Social Programme was arranged for the ladies and the delegates which included a visit to Messrs. Walker & Hall's famous Silverware and Cutlery Works and a visit to the theatre. Arrangements were made for members to look over the new Dental Hospital which was greatly admired, and excellent refreshments were provided. The delegates were accommodated at the Grand Hotel and were thus able to meet informally for discussion outside the lecture theatre.

At the closing of the meeting, the President said that he hoped all delegates had enjoyed the Congress and he expressed thanks to all those who helped to make it a success. He asked members to write to the Secretary expressing their views concerning the holding of similar meetings in future years so that the Council could be guided in their decisions.

THE TWO-FIFTY CLUB

THE Two-Fifty Club held their annual dinner in London on May 7 at the Victory Club. The club was formed in 1946 for non-regular ex-officers of the Royal Army Dental Corps and has met each year since its formation. Its potential membership runs into many thousands and it is hoped that each year will see a greater gathering of old friends. Not-so-old soldiers will recall that dental officers in the army were expected to fill 250 teeth per month during the war years—hence the name of the club.



The evening was spent in lively reminiscences and speeches by Dr. Senior, the chief guest, Brigadier Broderick, the President of the Club, and Major Hitchin, the Chairman, added lustre to the proceedings. The Secretary announced that the War Memorial Fund had been closed and a bed endowed in the Victory Club. A suitably worded plaque will be placed in the room and the Corps will now join many famous regiments and corps in presenting a permanent memorial to the Victory Club.

Next year will be the tenth anniversary of the club and it is hoped that the annual dinner will be made a special occasion for celebration. The comradeship of army years need not be forgotten while this club exists, and wherever one served, whether the Libyan desert, the plains of Lombardy, or the valleys of the Rhine, or whether a prisoner in the far east or nearer home, all will find a welcome.

THE NEW DENTAL SCHOOL AT THE SINGAPORE GENERAL HOSPITAL

Two years ago there was a serious lack of accommodation in the Dental School in Singapore, but a 50-ft. extension to the existing building, with basement, ground floor, and first floor, has now been completed. This has permitted the installation of approximately 21 more units in Conservative Dentistry, and seven more in Prosthetic Dentistry, and allowed a reorganization of the existing Dental School. The overall plan is to form three main clinical units: a Department of Conservative Dentistry, a Department of Oral Surgery, and a Department of Prosthetic Dentistry.

The main theatre and examination, diagnosis, and extraction room containing eight chairs are side by side and the new X-ray Department is situated between this section and the Conservative Clinic. Conservative Dentistry now has 46 units with a supply room and demonstration theatre, and immediately

adjoining is the Operative Technique Laboratory. In the Prosthetic Dentistry department there is a waiting room, offices, research laboratory, a Clinic of 16 units, demonstration theatre, and laboratory, all together on the first floor.

The Dental School takes in 1000 cases a week. Last year 63,500 patients were treated, of whom 36,250 were Chinese and more than half were children.

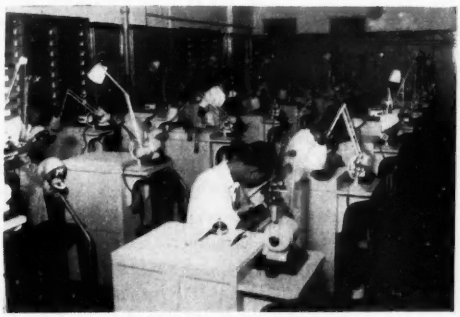


Fig. 1.—Part of the new dental clinic, Singapore.

Fig. 2.—Another view of the new clinic.

At the request of the Hong Kong Government, the University of Malaya will train dental students from that Colony. It is proposed from this year that approximately nine students from Hong Kong shall be admitted annually.

DENTAL RADIOGRAPHY

A TWO- or three-days course in dental radiography has been arranged for dental nurses and assistants to take place on Wednesday, Thursday, and Friday, Sept. 7, 8, 9, at the Ilford Limited Department of Radiography and Medical Photography, Tavistock House North, Tavistock Square, London, W.C.1.

Lectures will be given in the mornings from 10.0 a.m.–12.30 p.m., and in the afternoons of the first two days from 2.0–3.0 p.m. The rest of the time during the three afternoons will be devoted to practical demonstrations given on the X-ray units and in the darkrooms.

No fee is charged for this course. Application forms will be sent on request.

BAKER PLATINUM LTD.

BAKER PLATINUM LTD., Hanovia Products, Ltd., and Hanovia Ltd. have now linked up as one company under the name of Engelhard Industries Ltd. Baker Platinum is engaged in the refining and fabrication of precious metals; the production of dental golds and amalgam alloys; platinum laboratory apparatus, etc. Other products include the Dexo Process for catalytic gas purification and the nitroneal generator.

The name BAKER PLATINUM will continue to be used, and will form the Precious Metal Division of Engelhard Industries Ltd., 52, High Holborn, London, W.C.1 (Birmingham office: 123, Vyse Street).

Apology

Mr. C. P. Adams wishes to draw the attention of readers of this journal to a failure to acknowledge the authorship of the special technique of heat control for soldering fine wires to thick which was described in the DENTAL PRACTITIONER, June, 1955. He is indebted to Mr. J. R. Halden, of the Eastman Dental Hospital, who evolved and perfected this particular soldering technique, and regrets that acknowledgement of the source of this method was not given, an oversight which was quite unintentional.

BOOK REVIEWS

PARTIAL DENTURES. By JOHN OSBORNE, Ph.D., M.D.S., F.D.S., Professor of Dental Prosthetics, University of Birmingham, etc., and GEORGE A. LAMMIE, Ph.D., B.Sc., H.D.D., Senior Lecturer in Dental Prosthetics, University of Liverpool, etc. $8\frac{5}{8} \times 5\frac{1}{2}$ in. Pp. 374 + viii, with 205 illustrations. 1954. Oxford: Blackwell Scientific Publications. 42s.

IN writing *Partial Dentures* the authors have succeeded in producing a book of merit which should be appreciated by both student and practitioner. The blend of theory and practice is nicely balanced, the diagrams are clear and often self-explanatory, whilst repetition and cross-references are carefully avoided.

Classification of partial dentures is first considered. The Kennedy system is favoured, which is a good choice as it is probably the best known and the least complicated method which has yet been devised. This classification is outlined with others and the reasons for its choice made clear.

The scope and function of partial dentures is discussed from many angles including æsthetics, mastication, speech, and the continued health of the oral tissue.

The approach of the practitioner and the patient to such cases is followed by an assessment of the mechanical and bio-mechanical considerations. Diagnosis, treatment planning, and mouth preparation are dealt with in this order, followed by surveying. Here I feel the authors have gone astray a little. Completing the mouth preparation in respect of occlusal rests, and modifying contours will certainly lead the operator into trouble in many cases. Preliminary surveying on the study models would greatly help to decide those factors.

The materials, metallic and non-metallic, used in partial denture construction receive adequate attention in a brief chapter leading to the longest and probably the best chapter in the book headed "The Component Parts of a Partial Denture", in which all the possible parts of any partial dentures such as saddles, clasps—short and long arm, direct and indirect retainers, etc., are discussed from every relevant aspect.

The Kennedy classification is now examined class by class, including modifications, with reference to possible designs of actual cases. The diagrams and photographs here are a great help to quick understanding of the text.

The remaining part of the book takes one right through the various stages from the impressions to the fitting of a completed partial denture, and the final chapter is a brief summarizing of all the steps, both clinical and laboratory, in proper sequence from the initial examination of the patient to the finished case, and forms a most useful chart. This chart, if carefully followed, will ensure the production of high-grade partial dentures.

An immense amount of knowledge clearly and precisely stated is included in this moderate-sized volume. R. V. P. C.

PROGRESSIVE PRACTICE IN DENTISTRY. By EDWARD SAMSON, F.D.S., R.C.S. Eng., F.C.S. Third edition. $8\frac{1}{2} \times 5\frac{1}{2}$ in. Pp. 328 + viii. 1955. London: The Technical Press, Ltd. 25s.

ALTHOUGH more attention is being paid to the study of dental economics in the dental schools to-day, there is still a tendency to treat the subject as somewhat distasteful and unworthy of an equal place in the curriculum with the multiplicity of subjects which the student has to cope with.

The latest edition of Mr. Samson's book is worthy of the closest attention and study by the student approaching qualification, despite the author's opening sentence, as well as the newly qualified dental surgeon contemplating practice. The book has been completely revised and re-written to meet the changed conditions of practice which have occurred since the introduction of the National Health Service. The author's clear and concise style is familiar to many members of the profession from his many contributions to the dental literature, which makes the book readable—

something that cannot be said of many technical books. There is one criticism, however, that must be made—of the three hundred and twenty-six pages, six only are specifically devoted to a consideration of the National Health Service, in which most of the profession are either wholly or partially engaged. This, in the reviewer's opinion, detracts considerably from the value of the book, although much of the material can be applied or adapted for use in mixed or purely N.H.S. practice. This particularly refers to the chapter on choice of occupation, which deals exhaustively with the subject of assistantships and partnerships, giving details of specimen types of legal agreement. Valuable advice is given on premises and staff, but the chapter dealing with personal characteristics might be considered largely unnecessary by many readers. Fees and the various methods of assessing them are discussed in relation to the type of practice and patient. Some very useful specimen letters are shown for use in the case of reluctant payers. Among other matters dealt with are book-keeping, suitable types of stationery, the correct approach to the patient, and relations with the medical profession.

This is undoubtedly a book which should be read by all practising dentists, however well established and successful, to whom it may give food for thought. D. F. S.

CROWN AND BRIDGE PROSTHESIS. By Stanley D. Tylman, A.B., D.D.S., M.S., F.A.C.D., Professor of Prosthetics, Head of the Department of Fixed Partial Dentures, University of Illinois, College of Dentistry, Chicago, Illinois. Third edition. $9\frac{3}{4} \times 6\frac{3}{4}$ in. Pp. 1017 + xx, with 1364 text illustrations and 9 colour plates. 1954. London: Henry Kimpton. 120s.

Stanley Tylman's text-book on crown and bridge prosthesis has, since it was first published in 1940, become the accepted standard work on the subject, and he is to be congratulated on this third edition. It is a book that is essential to the postgraduate and the specialist practitioner, but the student may find it a little overwhelming in all its detail. The author states that an unsuccessful endeavour was made to cut down the size of the book but the text "just grew". Nevertheless, a more determined effort should be made for the next edition.

The book treats the subject on strict classical lines from the basic engineering and biological principles to the finished treatment. The theoretical aspect is well written and the aid of models to illustrate the forces that are brought to bear on these structures are cleverly conceived. Tylman's approach to the biomechanics of the oral mechanism sets an example to all teachers of restorative dentistry which will be difficult to improve. The book is practically impossible to criticize, except that perhaps it is too orthodox. There are no innovations or aids for the practitioner, no mention of the many types of parallelometers, no designs for the unusual crown or bridge, and, as in nearly all text-books, not nearly enough is given on the broken-down tooth and how it may be repaired and restored to function. This does not, however, detract from a book that is filled from cover to cover with a wealth of information.

The diagrams are extremely well drawn and special mention must be made of the really superb coloured plates. In contrast, the photographs of patients are astonishingly bad, a fact that is hard to understand. The price may seem high, but it is good value.

N. L. W.

DENTISTRY AS PRACTISED, 1800–1921. By J. Menzies Campbell, D.D.S., F.D.S., F.I.C.D., F.R.S.E., Hon. Member American Academy of the History of Dentistry. $9 \times 5\frac{1}{2}$ in. Pp. 11. 1955. Benevolent Fund of the British Dental Association. (Privately printed.) 2s. 6d.

This pamphlet is mentioned in the editorial, and is a brief survey of British dentistry from 1800 until 1921. The entire cost of this publication was defrayed by a small group of dentists, and the pamphlet is sold in aid of the Benevolent Fund of the British Dental Association. There are few pamphlets at such a small cost that contain so much worthwhile reading. N. L. W.

LETTER TO THE EDITOR

June 1, 1955.

Dear Sir,

Dr. Myers' interesting report on thioseconal in your May issue includes two tables of comparative speeds of elimination. The time of 3 min. 59 sec. shown in *Table II* is an inclusive time from start of injection. To compare with *Table I*, this should read—"Time to talk intelligibly .. 55 sec."

The alteration is not of great importance, as the speed and facility of the method as such cannot be approached by other forms of anæsthesia. The reduction in physical and mental shock to the patient is of greater importance.

My own experience is rather similar to that of Dr. Myers. Comparative tests of thioseconal and Surital, the U.S. equivalent, indicate that action and elimination are similar for both. This may seem a superfluous study, but those who have compared two brands of thiopentone (Pentothal and Intraval) may agree with me that the latter gives a smoother anæsthesia and is more completely eliminated in a shorter time than the former. Those who are further interested in thioseconal can therefore study the fairly extensive literature on Surital for a fair appraisal of the British product pending further reports.

If I may also refer to your editorial, it seems clear, after discussion with several anæsthetists, that those who practise hypnosis would be well served by studying the technique of venepuncture, and administering analgesic doses of one of the suitable barbiturates for the saving of much time and the simplification of many difficult inductions. Such a procedure would not come under the category of intravenous anæsthesia, but merely be a premedication.

Yours faithfully,

S. L. DRUMMOND-JACKSON.

53, *Wimpole Street*,
London, *W*.1.

Newton Heath Technical College

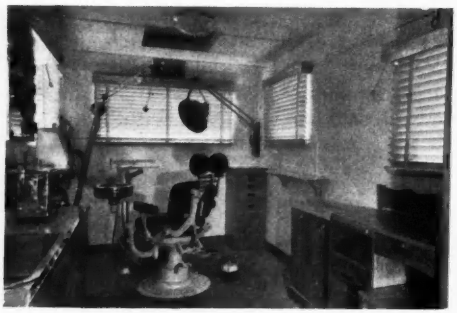
The Manchester and District Joint Training Committee for Dental Technicians. Prize Subscription: The following students attending the Dental Technicians courses at Newton Heath Technical College, Manchester, have been awarded prizes from the fund on the results of the 1954 examination:—

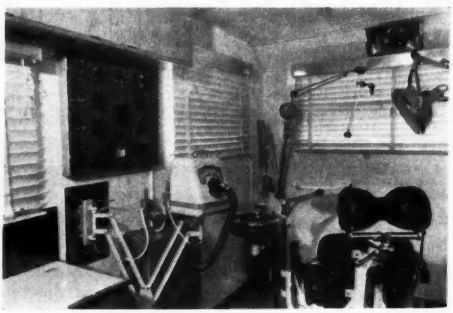
Final: First prize, A. J. Cash; Second prize, S. Jackson.

Intermediate: First prize, P. P. Burfield; Second prize, G. E. Ridyard.

A NEW MOBILE DENTAL CLINIC

THE two illustrations show the new mobile dental clinic bought by the Bedfordshire County Council for use in the outlying districts of that county. The unit is designed for all types of routine dental treatment and has many interesting features. The anæsthetic apparatus shown in the picture on the right is a good example of the careful planning of this mobile unit, which was built by Berkeley Coachwork Ltd., of Biggleswade.





NATIONAL HEALTH SERVICE NOTES

Maternity and Child Welfare Dental Services

A MEMORANDUM has been prepared, in agreement with the Ministry of Education, on dental services provided as part of the maternity and child welfare services under the National Health Service Acts.

The memorandum brings together the various statements of policy which have been made in the past and indicates ways in which the service may be developed and improved.

Appendix I contains notes on the planning of dental clinics.

Appendix II contains notes on the promotion of dental health designed as a basis for talks by dental officers, health visitors, and others.

Appendix III lists the suitable publicity material available.

Tribunal

As the result of an Inquiry held in Peterborough on May 13, 1955, the name of William Fielding, of 25 Broadway, Peterborough, is to be removed from the Dental List of the Executive Council for the County of the Soke of Peterborough; and shall not be included in any corresponding List kept by any other Executive Council under Part IV of the National Health Service Act, 1946.

ABSTRACTS
from Other Journals

Fibrocystic Salivary Tumour of the Mandible

Salivary gland tissue has been very rarely found within the bony structure of the mandible. A case is reported in which a cyst of the mandible originated in salivary gland tissue. A radiological diagnosis of a dental cyst was made, as X-ray examination showed a thin-walled smooth cyst in the ascending mandibular ramus expanding the bone and at one point a small section breaking through the thin cortex. Exploration was performed by the intra-oral route and a tumour, part solid and part cystic, was investigated. The cavity was found to communicate with the loose tissues of the neck below and behind the angle of the mandible. The lining epithelium was completely excised. The cavity was loosely packed with "Vaseline" gauze and the patient made an uneventful recovery. A post-operative sialogram showed a normal submandibular duct and gland.

The histological examination revealed the presence of muscle, fat, blood-vessels, nerves, and mucus-secreting salivary tissue only. As there was no evidence of serous secreting salivary tissue, it is suggested that enclosed within the mandible a portion of submandibular gland might well have remained in its primitive state and failed to differentiate into serous tissue.—MATHIESON, A. J. M. (1954), *Brit. J. Surg.*, **42**, 173, 327.

Impression Materials

All impression materials have certain requirements in common—they must not be harmful to the tissues, or be unpleasant to the patient. They should accurately reproduce all areas, and possess and retain dimensional stability, upon removal from the mouth, and during storage.

Plaster-of-Paris.—One of its most serious disadvantages is its porosity. This is traceable to three causes: air present in the powder, air incorporated during mixing, and air trapped during pouring the model.

This can be avoided by sifting the powder into the water, mixing or investing under vacuum, mechanical spatulation, and by the use of hand shakers.

Impression Materials.—Hydrocolloid impression materials can be either reversible or irreversible. In the former it is a physical change, and in the latter a chemical reaction. The advantages of reversible hydrocolloids are: (*a*) fewer human variables in technique; (*b*) less variation in batches; (*c*) sharper detail; (*d*) slightly better stone surface; (*e*) greater accuracy on long span.

These impressions should be removed with a sharp thrust in a direction parallel to the long axis of the teeth, as the material has greater strength when subjected to a sharp sudden force than a slowly applied or static pressure. Alginate impressions require the use of a fixing solution to accelerate the set of the plaster, to prevent a softening of the plaster surface, and to stabilize the impression when storage is necessary. The impressions should be poured as soon as possible to avoid distortion. When the impression cannot be poured immediately, it is best stored in an atmosphere of greatest humidity.

Before pouring the model saliva and debris should be gently washed out, excess droplets of water or fixing solution should be gently blown from the surface of the impression, and the correct water–plaster ratio should be followed.

Causes of failure, using hydrocolloids, are lack of use of fixing solution, leaving impression too long in the mouth or in the humidor, use of old materials, and movement of tray during gelation, etc.

Zinc-oxide–eugenol impression materials vary widely in setting time, surface detail reproduction, strength, and flow, according to their manufacture.—PHILLIPS, R. W. (1954), *Int. Dent. J.*, **4**, 705.

Root Resorption in Human Permanent Teeth

The literature is comprehensively reviewed and an analysis of 708 sets of radiographs of complete dentitions containing a total of 13,263 permanent teeth in patients between the ages of 12 and 49, none of whom have undergone orthodontic treatment, together with a study of similar radiographs for 81 patients in an age group between 12 and 19 years who had undergone orthodontic treatment, is reported and discussed. It was found that:—

1. 100 per cent of the persons examined showed some evidence of periapical resorption in one or more of the permanent tooth roots.

2. 86·4 per cent of the teeth examined showed evidence of some resorption. Only 1·6 per cent of the teeth revealed (roentgenographically) no evidence of resorption. The remaining 12 per cent of the teeth were questionable.

3. An average of 16 teeth per person showed some evidence of periapical resorption. There were no striking differences between males and females.

4. There were no significant differences between the number of maxillary and mandibular teeth affected. The resorptive pattern was strongly bilateral.

5. The order of susceptibility of teeth to resorptions in this study was consistent with other studies.

6. In only 5 per cent of the teeth was there any evidence as to the cause of the resorption (periapical infection and root canal therapy). In 81·2 per cent of the teeth no reasons for the resorption were obvious (idiopathic resorptions).

7. The distribution of idiopathic resorptions in unselected cases was as follows:—

a. 71 per cent were mild, the apex of the root being only slightly blunted.

b. 9 per cent showed moderate amounts of resorption (root resorbed for at least 2–4 mm.).

c. 0·30 per cent were severely resorbed (root resorbed 4 mm. to one-fourth root length).

d. 0·11 per cent showed very severe resorption (more than one-fourth of the root resorbed).

8. There appeared to be a significant increase in the frequency of the more severe degrees of resorption with age.

9. The intra-oral roentgenograms of 81 orthodontically treated patients also were assessed. It was found that the number of teeth resorbed, and particularly the severity of the resorptions, were markedly increased by orthodontic procedures.

10. In a sample of 76 cases treated orthodontically, a good prediction as to the degree of root resorption after orthodontic treatment could be made by analysis of the roentgenograms taken before treatment. This prediction was more accurate when individual teeth were assessed before and after treatment than when the case was assessed as a whole.

11. It is concluded that a definite resorptive potential is resident in the permanent (as well as the primary) teeth of all persons. This resorptive potential varies in different persons and also in different teeth of the same person. The resorptive potential was found to be inherently high in approximately 10 per cent of this sample. This figure correlates well with the approximately 14 per cent of teeth showing severe degrees of resorption after orthodontic treatment.—MASSLER, M., and MALONE, A. J. (1945), *Amer. J. Orthodont.*, **40**, 619.

The Effect of High Kilovoltage on Hard and Soft Tissue Definition in Lateral Cephalometric Roentgenograms

This is a preliminary report of a series of experiments in high kilovoltage and very low milliamperage radiation exposure time in lateral cephalometric roentgenography. The object was to develop a technique which would register both soft and hard tissues in lateral cephalometric roentgenograms.

According to most radiologic techniques, a low kilovoltage is necessary for good soft-tissue definition. That is true if only the soft-tissue rendition is the objective. However, with this low kilovoltage technique, the hard tissues are very poorly defined. It followed, then, that by increasing the kilovoltage, and thereby proportionately increasing the penetrating power of the X rays, the hard tissues should be better defined; but then again this resulted in the soft tissues being lost on the developed film.

The problem was to devise a standardized technique in lateral cephalometric roentgenography which would show the soft tissues draping over the skeletal framework without losing good definition of bone tissue and its important landmarks.

Experiments were carried on by gradually increasing the kilovoltage and decreasing the milliamperage seconds.

A technique using 90 kVp., 20 ma. at $\frac{3}{10}$ second was used for thirty-four roentgenograms, and the soft as well as the hard tissues were well defined on the film. The patients' ages ranged from 5 years 7 months to 69 years 6 months.

Further investigations with the use of aluminium filters are being carried on at the present time.—FRANKLIN, J. B. (1954), *Amer. J. Orthodont.*, **11**, 837.

EXAMINATIONS OF THE DEGREE OF BACHELOR OF DENTAL SURGERY AND THE LICENCE IN DENTAL SURGERY JUNE, 1955

UNIVERSITY OF DURHAM

JUNE, 1955

THE following students have satisfied the Examiners:—

Final Examination for the Degree of Bachelor of Dental Surgery:—

Appleton, K. B., Armstrong, J. L., Aylwin, A. J. M., Baboolal, W.O., Brow, D. P. (2nd Class Honours with Distinction in Part II), Burrell, S. K., Cannon, L. J., Chisholm, H. K., Cummings, R. N. F., Davidson, C., Davidson, K. G., Hadden, E. J., Harrison, D. J., Hartford, R. B., Hodgson, E. B., Holliday, W. D., Hudson, J. R., Hudson, J. H., Hughes, K., Johnson, F. A., Jones, N. L., McCree, M., McGregor, A. J. (2nd Class Honours with Distinction in Part II), McIntyre, W. E. M., McKelvey, J. A., Porteous, J. R., Potter, A., Pyle, W., Robinson, Miss L. M., Sayburn, M. A., Servant, S. B., Spark, Miss A. W., Sullivan, J. F., Todd, E., Vadgama, J., Webber, Miss J., Willis, J. K., Wood, I. A.

Final Examination for the Degree of Bachelor of Dental Surgery, Part I:—

Angus, D. A., Black, Miss B. H., Blight, Miss J., Bloch, W. W., Breakey, L. F., Brown, Miss A. E. M., Carter, H. R., Casartelli, J. V. P., Davidson, D. P., Dunlevy, T. A. P., Dunlop, A., Ebrahim, I. A., Ejide, A. O., Ellerton, D. A., Foreman, P. C., Gibbs, Miss L. Y., Graham, G. S., Grainger, J., Haddon, R. M., Hatimi, H. A., High, E. A., Hopkins, R., Isaac, D. G., Kenagaraja, S., Khadaroo, S., Lawson, G., Lodge, B., Long, G. C. J.,

Mason, Miss J., Murray, I. D., Norris, H. D., Onwurah, M. O., Phillips, D. G., Phillips, M. E., Quinn, Miss M. P., Reece, J. W., Sinclair, N. F. C., Stewart, N. S., Symington, J. M., Takyi, S. H., Thompson, J. H., Wise, A.

Final Examination for the Licence in Dental Surgery:—
Allen, L. W., Beetham, E. F., Campbell, A. B., Cassimally, A. I., Clarke, D. W., Cook, R. J., Currie, Miss M. M., Everitt, A. D., Furness, J., Hamilton, R. K., Jefferson, H., Joseph, L. E. L., Kurer, P. F., McGhee, H. G., Nanda, R. N., Paterson, A. K., Pettman, J. R., Playford, J. V., Richardson, G. Y., Scaife, J. S. L. (B.Sc.), Shelton, M. E., Stephenson, G., Ward, K. A.

Final Examination for the Licence in Dental Surgery, Part I:—
Gell, F. E.

Fourth Examination for the Degree of Bachelor of Dental Surgery:—
Back, D. C., Bell, M. H., Birch, R. V., Bloom, B. W., Brown, Miss H. M. C., Catheside, J., Chadwick, I., Collins, Miss M., Crosbie, B. W., Davies, G. N., Ellis, P. M., French, M. S., Fronman, S., Geffner, I., Glenwright, H. D. (with Distinction in Part II), Golding, Miss K. M., Gooder, M. E., Goodley, A. K., Green, H. E. B., Johnson, Miss S., Khan, S. A., Lewis, D. R., Lindsay, D. M., McKenzie, R., Molloy, J. K., Moss, B., Nand, R. M., Oliver, Miss M. B., Padayachy, P. N., Park, L. T., Plummer, K. E., Richardson, M. C., Robson, P. S., Rouse, W. M., Sheard, M. J. R., Taylor, V. E., Thompson, H., Thompson, R., Wilson, D., Wimaladharma, W. G.

Fourth Examination for the Degree of Bachelor of Dental Surgery, Part I:—
Calow, Miss D. E. M., Moodaley, S. N., Walton, Miss H. M.

Fourth Examination for the Licence in Dental Surgery:—
Bell, M. D. E., Bhinda, S. V., Daniels, T. G., Foulds, R. M., Javid, B., Pascal-Murray, H. F., Rothwell, R. M., Saravanamuttu, J. S., Solan, J., Yee-Chong, H.

Fourth Examination for the Licence in Dental Surgery, Part I:—
Henshaw, N. E., Taylor, A. C., Wrigley, P. C.

Third Examination for the Degree of Bachelor of Dental Surgery:—
Aaron, R., Abbott, E., Abrahams, M., Adair, B., Bancroft, G. H., Bluck, D. R., Charlton, G., Clark, A. M., Clucas, R., Cowell, T. A., Dewell, D., Etherington, Miss L., Gough, N. G., Harrison, T. D., Howlett, R. A. N., Hunter, J. B., Ipaktchi, A. H., Madhoo, P., Marshall, G., Matthews, C. S., Morgan, A. R., Neden, Miss J., Neverlien, P. O., Redhead, P. A., Ridley, T. J., Rowlay, Miss R. A., Serfontein, D. D. (with Distinction), Spencer, J., Stubbs, J. M., Vorster, S. W., Wallace, J. D.

Third Examination for the Licence in Dental Surgery:—
Aniis, M. R., Christalis, A., Ferrell, R. S., Forster, P. E., Harper, M. J. C., Joyce, M. W., Levin, H., Naru, B. S., Newman, E. H., Nirsimloo, P. C., Pepple, Miss G. A., Ressum, O., Rosen, M., Rothfield, J. S., Selby, G. K., Smith, T. O., Sowter, P. J., Widdicombe, J. R., Wold, K. O., Wright, E. B.

Second Examination for the Degree of Bachelor of Dental Surgery:—
Allan, W. C., Carapeti, S. A., Carruthers, J. S., Carter, J. E., Drury, W. J., Elston, C. S., Fairpo, C. G., Greenburgh, R. L., Hutchinson, P. D., Koranteng, L. O., Lang, D. G. E., Mokrzycki, J., Safinia, F. (with Distinction in Anatomy), Simpson, M. W., Sockett, M., Teasdale, J. W. (with Distinction in Anatomy), Willis, P.

Second Examination for the Licence in Dental Surgery:—
By, R., Funderud, Miss T., Hagen, K., Hardy, E. G., Henriksen, Mrs. B., Henriksen, E. O., Hjardeng, H. V., Evaale, Miss T., Loe, L. E. (with Distinction in Anatomy), McMeekin, P. A., Morrison, J. K., Mortensen, R. M., Naidoo, R., Rasmussen, T. H., Robinson, B., Rogstad, S. B.

First Examination for the Degree of Bachelor of Dental Surgery:—
Ana, J. R., Cloete, J. G., Egan, J. F., Fawcett, P. E., Hedley, W., Hilton-Bailey, I., Lifschitz, M., Molloy, Miss D., Padayachee, S., Priestley, M. S., Tate, J. M., Thomas, J. F. G., Wilson, G. E.

First Examination for the Licence in Dental Surgery:—
Berrystone, Miss E. M., Danbolt, N. N., Davies, J. R., Drinkwater, J. M., Feinberg, L. T., Fraser, B. M., Garsrud, O., Haral, K., Hassel, H. S., Haust, G., Hoidahl, O. A., Hugaas, D. A., Jackson, W., Julsvoll, B. N., Manderson, R. D., Oosthuysen, J. J., Padayachee, D. N., Petterson, O. H., Pickford, T. B., Preston, Miss G. A., Sheff, A. F., Short, Miss M. K., Stormo, K., Svanaes, D.

UNIVERSITY OF LIVERPOOL

Final Examination for the Degree of Bachelor of Dental Surgery, Part I:—
Atherton, J. D., Goward, P. E.

Third Examination for the Degree of Bachelor of Dental Surgery, Part II:—
Barlow, D. J., Gilbert, J. W., Lloyd-Williams, Margaret J., Tobin, R. J., Yearsley, Susan.

Third Examination for the Licence in Dental Surgery, Part II:—
Barron, D. W., Golding, A. A., Hall, C. M., Hudaly, S. I. T., Hutchinson, R. R., Issa, H. I., Magee, H. C., Naess, T. K., Petty, B., Ryan, J. F., Simkins, W., Sowerby, C. A., Thom, I. H.

Second Examination for the Licence in Dental Surgery, Part I:*—
Clegg, J. H. (1), Love, P. S. (1, 2), Petterson, B. I. (1, 2), Smith, H. (2), Stephenson, R. S. (2), Tweedie, T. O. (1, 2), Warner, Marie A. (1, 2).
* (1) Passed in Anatomy. (2) Passed in Physiology and Biochemistry.

Second Examination for the Degree of Bachelor of Dental Surgery, Part II (b):—
Jenkins, Ruth J., Pearse, D. R.

Second Examination for the Licence in Dental Surgery, Part II (b):—
Carling, W. H., Cooper, M. W., Farrington, D., Holland, Pamela M.

Second Examination for the Licence in Dental Surgery, Part II (a):—
Carling, W. H., Cooper, M. W., Holland, Pamela M.

Second Examination for the Degree of Bachelor of Dental Surgery, Part II (c):—
Pearse, D. R.

Second Examination for the Licence in Dental Surgery, Part II (c):—
Densley, A. F., Downer, M. C., Farrington, D.

First Examination for the Degree of Bachelor of Dental Surgery:*—
Atlay, R. D. (a, b), Day, J. M. (a), Grimshaw, J. B. (c), Lamb, E. (c), Robinson, Margaret E. (b), Schioth, J. (a, b), Shields, H. A. (a, b), Wilkinson, Phyllis M. (b).

First Examination for the Licence in Dental Surgery:—
Aspestrand, R. G. (c), Brunvand, E. (c), Kennedy, Marie P. (b), Sandham, J. (c), Williamson, J. E. (b, c).
* (a) Passed in Chemistry. (b) Passed in Physics. (c) Passed in Biology.